Civil Aviation Safety Authority
of Papua New Guinea

Advisory Circular
AC125-3

Single – Engine IFR Operations (SEIFR)

Initial Issue

01 December 2022

GENERAL

Civil Aviation Safety Authority Advisory Circulars (AC) contain information about standards, practices and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

This Advisory Circular also includes Explanatory Material (EM) where it has been shown that further explanation is required. Explanatory Material must not be regarded as an acceptable means of compliance.

PURPOSE

This Advisory Circular provides methods acceptable to the CASA for the conduct of single turbine engine aeroplane operations under Papua New Guinea Rule Part 125.

RELATED CAR

This AC relates to CAR Parts 125.1. 125.3. 125.9, 125 Subpart M and associated Appendices.

CHANGE NOTICE

There was no previous issue of this AC, consequently no change is in effect.

APPROVAL

This AC has been approved for publication by the Director of Civil Aviation

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1. Applicability

CAR Part 125, inter alia, prescribes the Rules governing air operations using an aeroplane:

(1) Having a passenger seating configuration of 10 - 19 seats or less, excluding any required crew member seat, or

(2) Having a payload capacity of 2500 kg or less, and a MCTOW of greater than 5700 kg, or

(3) To perform a SEIFR operation.

In respect of SEIFR operations, CAR Part 125.9 has been revised to state:

"The certificate holder shall not conduct a SEIFR operation unless:

(1) The SEIFR operation is specified in their operations specifications under CAR Part 119.13(b)(5), has the approval of the Director, and

(2) The operation is performed in accordance with this Part, and

(3) The aeroplane is a single engine turbine powered aeroplane, and

(4) The aeroplane has a passenger seating configuration of nine (9) seats, or less, excluding any required crew member seat and a payload capacity of 2500 kg or less, and

(5) The aeroplane has a maximum certificated mass that does not exceed 5700 kg or less, and

(6) The Aircraft Flight Manual includes limitations, procedures, approval status and other information relevant to operations by single engine turbine powered aeroplanes at night and/or in IMC".

This Advisory Circular deals specifically with the operation of single engine turbine powered aeroplanes at night and/or in IMC.

2. Introduction

2.1 In the past, Annex 6, Part I ("Commercial Air Transport") of the ICAO Convention stated "Single engine aeroplanes shall only be operated in conditions of weather and light, and over such routes and diversions there from, that permit a safe forced landing to be executed in the event of engine failure."

2.2 These prohibitions were formulated decades ago on the basis of the reliability of the reciprocating engines of the time. It is now generally considered turbine engines offer far greater reliability and performance than the powerplants on which past legislation was based.

2.3 Until 01 January 2004, the PNG Civil Aviation Rules conformed to this recommended practice, prohibiting commercial operations in single engine aircraft at night or under the IFR. An exception was made for commercial operations which did not carry passengers for hire or reward (i.e. freight-only commercial operations). This had also been the practice in most major ICAO signatory States.

2.4 CAR Part 125, effective from 01 January 2004, was revised to include requirements for the operation of single engine turbine powered aeroplanes carrying passengers for hire or reward. This revision was undertaken to harmonise with changing international practices, however, the revision was not supported by advisory material containing Acceptable Means of Compliance (AMC) or Explanatory Material (EM) nor was the revision supported by careful risk analysis.

2.5 The International Civil Aviation Organisation (ICAO) revised Annex 6, Part 1, in July 2010, to provide standards and recommended practices (SARPs) permitting States to allow single-engine turbine powered aeroplanes to carry revenue passengers in air transport operations at night and under the IFR by adopting the SARPs in State legislation.

2.6 CAR Part 125 was further revised in 2015 to make all (both passenger and cargo carriage) single engine turbine powered aeroplanes operating under the IFR and/or at night, subject to the provisions of the pertinent parts of CAR Part 125. This revision was still not accompanied by AMC and EM material nor was it supported by careful risk analysis.

2.7 This Advisory Circular (AC) is promulgated to draw industry attention to a further refinement of CAR Part 125, in respect of SE-IFR operations, and to provide an Acceptable Means of Compliance with the revised Rule and to provide Explanatory Material. It also discusses the risk analyses undertaken by various international regulators which are acceptable to CASA.

2.8 Given the much improved reliability of the modern turbine engine, and associated systems, compared with reciprocating engines, and the availability of single engine aeroplanes powered by turbine engines which meet current reliability requirements, the aviation industry in PNG is starting to express interest in operating such aeroplanes for single engine turbine IFR operations. This is the prime reason for the latest revision of CAR Part 125 and the promulgation of this AC.

3. Discussion and Risk Analysis

3.1 Analysis of the accident data for C208s operated in the USA from 1985 to 1991 indicate that there were five mechanical propulsion system-related accidents. No accidents occurred during IMC as the result of propulsion or other system failure even though most of the operations during the period were performed by overnight package delivery services operating in all weather conditions.

The overall propulsion-related accident rate of 0.76 per 100,000 hours for the C208 is midway between the air taxi industry overall propulsion failure accident rates of 0.17 and 1.42 per 100,000 hours for multi-engine and single-engine airplanes respectively. It should be noted that the C208 data were based on early data; more recent data indicate a substantially lower propulsion failure accident rate. To date, the C208 has more than 22 million flight hours. The study estimated that the probability of a propulsion system-related, single engine airplane accident in IMC that resulted in serious consequences is one in over 600,000 total hours of operation when using properly maintained, current technology aeroplanes are flown by proficient pilots.

Note 1: The above C208 data and risk analysis were provided by MAF PNG Ltd in support of their SEIFR approval. Other PNG air operators intending to obtain SEIFR approval for other aircraft types should provide similar data and associated risk analysis in support of their respective SEIFR approval applications.

3.2 A question the FAA then asked was whether this risk was acceptable and how the risk compared to the risk associated with current restrictions at the time. A position paper developed by the then Australian Bureau of Aviation Safety Investigation (BASI), now the ATSB, stated that most modern single-engine airplanes operate at cruise altitudes that provide significant glide capability in the event of engine failure. In addition, the failure of one engine in a multi-engine airplane creates control problems that narrow the safe flight regime and raise pilot workload. Australian data indicates that twin-engine aeroplanes flew 770,000 hours per serious accident while single-engine aeroplanes flew 1.8 million hours per serious accident. The study concluded that "given a reasonable degree of engine reliability and the greater complexity of handling a twin-engine airplane, it is questionable whether twin-engine airplanes are indeed safer in all cases". It should be noted, however, modern single turbine engine unpressurised aeroplanes in PNG cannot always operate at cruise altitudes that provide significant glide capability in the event of engine power loss due to the height and nature of the terrain. This is a consideration which must not be ignored.

3.3 The FAA selected the .01/1,000 hours because it is a statistically meaningful basis for ensuring the reliability of engines. It is consistent with the MTBF used by Canada, Australia and New Zealand and proposed by EASA and with reliability rates required by ICAO. When Canada selected this MTBF, it was half the ETOPS (extended. twin-engine. over water operations) target of .02/1.000 hours. Because the small engine rate was better than the ETOPs target, Canada selected .01 /1,000 hours, which was historically representative of a mature small gas turbine engine.

3.4 On 15 October 2007, QinetiQ published a comprehensive report following a risk assessment, commissioned by EASA, of the operation of single engine turbine (SET) aeroplanes in public transport operation. The report is titled "Risk Assessment for European Public Transport Operations using Single Engine Turbine Aircraft at Night and in IMC". The afore-mentioned report concluded:

3.4.1 There were no reasons, other than engine failure, why the SET should be more at risk than a twin-engine aircraft when operating at night or in IMC. In the European context, the target fatal accident rate for SET operating in accordance with NPA OPS Rev 2 should be no greater than 4 x 10^{-6} per flight hour from all causes.

3.4.2 The fatal accident rate following engine failure should be no greater than 33% of the overall rate (1.3 x 10^{-6} pfh). This target is less than the historic rate for twin engine aircraft which, depending on the sources used, was shown to be between 1.6 to 2.4 x 10^{-6} pfh.

3.4.3 In considering the likely SET fatal accident rate following engine failure, consideration was given to the statistics from UK General Aviation over the period since 1990 as well as from military experience with single engine aircraft. It was concluded that in day/VMC it was reasonable to expect that SET in commercial operation should not exceed a fatal accident rate of 0.5 x 10^{-6} pfh. As the historic SET fatal accident rate following engine failure was actually 0.16 x 10^{-6}, this expectation appeared conservative.

3.4.4 The report concluded by recommending that an applicant for SET IMC public transport operations must conduct a risk assessment for specific routes. This will allow the risk to be estimated and, if the applicant can show that the risk of an unsuccessful forced landing following engine failure is more remote than 1.3 x 10^{-6} pfh then it is recommended that the route and the associated weather minima be approved.

3.5 The System Safety Directorate of Transport Canada conducted an Operational Safety Review of turbine powered single engine aeroplane commercial passenger operations at night and in IMC. The review aimed "to identify potential hazards and assess associated risks" of such operations.

The Safety Review Team's risk assessments led to the broad conclusion that greater risks are posed to a flight by reason of it being conducted in IMC, or by a single pilot, than by it being conducted in a single engine aircraft. Operational experience indicates that engine failures are not a statistically significant problem, with the mean time between inflight shutdowns for all PT6 turboprops reported by Pratt and Whitney to be one per 125,000 flying hours to 30 June 1993.

3.6 Based on the aforementioned studies and reviews it can be reasonably concluded that an engine power loss rate of 1 x 10^{-6} is conservative and reasonable for SE-IFR operations. However, given the nature of PNG's high and rugged terrain, generally high lowest safe altitudes and a scarcity of suitable aerodromes and safe forced landing areas coupled with difficult meteorological conditions, serious consideration must be given to the safety viability of specific routes for SE-IFR public transport operations. This will require an applicant for SE-IFR operations to conduct a risk assessment for each specific route to allow the risk to be estimated and to demonstrate to the Director that the risk of an unsuccessful forced landing following engine power loss is more remote than 1.3 x 10^{-6} pfh.

4. Vision Systems

4.1 The area navigation system required for SEIFR operations shall be supplemented by the fitment of one of the following: a head up display (HUD), an enhanced vision system (EVS), a synthetic vision system (SVS) and/or a combined vision system (CVS), or any combination of those into a hybrid system.

4.2 Such systems are required to assist the pilots with situational awareness in normal and emergency operations and to assist them in the identification of critical terrain and obstacles and the identification and confirmation of suitable safe forced landing areas.

4.3 An approved Area Navigation System supplemented by the installation of EVS, SVS or CVS and the fitment of TAWS, as required by Part 125, will significantly improve the accuracy of navigation. This will also have the added advantage of providing improved awareness of the proximity of critical terrain and obstacles and go some way to mitigating the overall operating risk of operating single engine turbine aeroplanes over and through operationally difficult areas.

5. Performance Based Navigation (PBN)

5.1 PBN is the outcome of the continuing growth of aviation's increased demands on airspace capacity therefore emphasizing the need for optimum utilization of available airspace. Improved operational efficiency, derived from the application of area navigation (RNAV) techniques, has resulted in the development of navigation applications in various regions worldwide and for all phases of flight. These applications could potentially be expanded to provide guidance for ground movement operations.

5.2 Requirements for navigation applications on specific routes or within a specific airspace must be defined in a clear and concise manner. This is to ensure that the flight crew and the air traffic controllers (ATCs) are aware of the on-board RNAV system capabilities in order to determine if the performance of the RNAV system is appropriate for the specific airspace requirements.

5.3 RNAV systems have evolved in a manner similar to conventional ground-based routes and procedures. A specific RNAV system was identified and its performance was evaluated through a combination of analysis and flight testing. For domestic operations, the initial systems used very high frequency omnidirectional radio range (VOR) and distance measuring equipment (DME) for estimating their position; for oceanic operations, inertial navigation systems (INS) were employed. These "new" systems were developed, evaluated and certificated. Airspace and obstacle clearance criteria were developed based on the performance of available equipment; and specifications for requirements were based on available capabilities. In some cases, it was necessary to identify the individual models of equipment that could be operated within the airspace concerned. Such prescriptive requirements resulted in the need to define aeroplane equipment requirements by specifying the navigation performance requirements for some or all phases of flight. This is termed performance based navigation (PBN).

5.4 The PBN concept specifies that aircraft RNAV system performance requirements be defined in terms of the accuracy, integrity, availability, continuity and functionality, which are needed for the proposed operations in the context of a particular airspace concept. The PBN concept represents a shift from sensor-based to performance-based navigation.

5.5 Performance requirements are identified in navigation specifications, which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements.

5.6 PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria, i.e.:

(a) reduces the need to maintain sensor-specific routes and procedures, and their associated costs;

(b) avoids the need for developing sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive;

(b) allows for more efficient use of airspace (route placement, fuel efficiency and noise abatement);

(c) clarifies how RNAV systems are used; and

(e) facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

5.7 Within an airspace concept, PBN requirements will be affected by the communication, surveillance and Air Traffic Management (ATM) environments, the navaid infrastructure, and the functional and operational capabilities needed to meet the ATM application. PBN performance requirements also depend on what reversionary, non-RNAV means of navigation are available and what degree of redundancy is required to ensure adequate continuity of functions.

5.8 During development of the performance-based navigation concept, it was recognized that advanced aircraft RNAV systems are achieving a predictable level of navigation performance accuracy which, together with an appropriate level of functionality, allows for more efficient use of available airspace.

5.9 The nature of the high terrain in PNG, and the consequent high lowest safe altitudes (above 10000 ft) for flight under the IFR, makes it impossible for unpressurised single engine turbine powered aircraft to operate in an unrestricted fashion due to being limited to a maximum cruise altitude of 10000 ft. The use of PBN routes for such aeroplanes has the potential to permit less restricted operations for SEIFR operations.

5.10 Non-PBN operations utilise angular lateral obstacle identification areas which pick up critical obstacles in a much wider area that PBN operations which have linear lateral obstacle identification areas. This means that many obstacles identified as critical in the non-PBN areas are excluded in the PBN areas which means lower safe altitudes for SEIFR operations. This is achieved practically by having a tighter and more accurate lateral navigation specification such as required by RNAV and RNP.

5.11 The navigation specification is used as a basis for the development of material for airworthiness and operational approval. A navigation specification details the performance required of the RNAV system in terms of accuracy, integrity, availability and continuity; which navigation functionalities the RNAV system must have; which navigation sensors must be integrated into the RNAV system; and which requirements are placed on the flight crew. A navigation specification is either an RNP specification or an RNAV specification. An RNP specification includes a requirement for on-board self-contained performance monitoring and alerting, while an RNAV specification does not.

5.12 For oceanic, remote, en-route and terminal operations, an RNP specification is designated as RNP X, e.g. RNP 4. An RNAV specification is designated as RNAV X, e.g. RNAV 1. For both RNP and RNAV designations, the expression “X” (where stated) refers to the lateral navigation accuracy in nautical miles, which is expected to be achieved at least 95 per cent of the flight time by the population of aircraft operating within the airspace, route or procedure.

5.13 In cases where navigation accuracy is used as part of the designation of a navigation specification, it should be noted that navigation accuracy is only one of the many performance requirements included in a navigation specification.

5.14 Because specific performance requirements are defined for each navigation specification, an aircraft approved for an RNP specification is not automatically approved for all RNAV specifications. Similarly, an aircraft approved for an RNP or RNAV specification having a stringent accuracy requirement (e.g. RNP 0.3 specification) is not automatically approved for a navigation specification having a *less* stringent accuracy requirement (e.g. RNP 4). It may seem logical, for example, that an aircraft approved for Basic-RNP 1 be automatically approved for RNP 4; however, this is not the case. Aircraft approved to the more stringent accuracy requirements may not necessarily meet some of the functional requirements of the navigation specification having a less stringent accuracy requirement.

6. Explanatory Material (EM)

6.1 EM Part 125.9(1)

With regard to approval of the C208 aeroplane by the Director under CAR 119.13(b)(5) the Director shall take account of the requirements of CASA Australia Type Acceptance Certificate No. A320 which states at TCDS Conditions and Limitations 1 and 2:

1. Model 208 aircraft equipped with PT6S-114A or PT6A-114 engines, and Model 208 aircraft that have been modified in accordance with FAA STC SA02467LA or CASA STC SVA554 and equipped with PT6A-42A engines are eligible for Approved Single Engine Turbine Powered Aircraft (ASETPA) operations pursuant to CARs (1988) 174B and 175B.

   This eligibility does not constitute approval to conduct SEIFR operations.

2. Where the aircraft has been modified from a standard production configuration, or the aircraft has not been listed at Point 1 above, additional assessment by CASA and approval against the airworthiness requirements of Australian Civil Aviation Order (CAO) 100.5 and CASA Australia Advisory Circular (AC) 21-38 will be required before the aircraft can be considered eligible for SEIFR operations.

Note 1: With regards to SEIFR approval of aeroplane types other than the C208, the Director shall take into account any applicable requirements of other design States listed in Part 21 Appendix B(a)(1).

6.2 EM Part 125.9(3) Maximum seating capacity

To harmonise with the certification requirements of FAR Part 23, the maximum seating capacity required by the current PNG CAR Part 125.9(3) will be revised from the current 14 seats or less to 9 seats or less. This rule change has been scheduled in the 2024 NPRM cycle.

6.3 EM Part 125.903(1)(iii) and (2)

FAR Part 23 prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for airplanes in the normal, utility, acrobatic, and commuter categories and describes the certification requirements for aeroplanes.

It should be noted that FAR Part 23 categorises aeroplanes as:

(a) The normal category is limited to aeroplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated take-off weight of 12,500 pounds (5700 kg) or less, and intended for non-aerobatic operation.

(b) The utility category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated take-off weight of 12,500 pounds or less, and intended for limited aerobatic operation.

(c) The aerobatic category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated take-off weight of 12,500 pounds or less, and intended for use without restrictions, other than those shown to be necessary as a result of required flight tests.

(d) The commuter category is limited to multi-engine aeroplanes that have a seating configuration, excluding pilot seats, of 19 or less, and a maximum certificated take-off weight of 19,000 pounds or less.

(e) Except for commuter category, aeroplanes may be type certificated in more than one category if the requirements of each requested category are met.

PNG CAR Part 21.35 prescribes PNG airworthiness standards as:

(a) Standard category airworthiness certificate.

(b) Restricted category airworthiness certificate.

(c) Special flight permit.

The PNG Standard Category Airworthiness Certificate is equivalent to the FAA FAR Part 23 Normal Category Airworthiness Certificate thus, to harmonise with the certification requirements of FAR Part 23, the maximum seating capacity required by CAR Part 125.9(3) has been revised from14 seats or less to 9 seats or less.

6.4 EM Part 125.903(1)(v)

The level of safety requirements intended by Annex 6 and Annex 8 have been generally incorporated into the PNG Rules, therefore, if the applicant for SEIFR operations approval meets the pertinent PNG legislative requirements, they can be reasonably confident they meet the overall level of safety prescribed at Annex 6 and Annex 8.

6.5 EM Part 125.903(2)(Note 2)

The statistics for the determination of power loss rate may be compiled from world-wide type operations and is allowed by ICAO and some major regulators. Notwithstanding this, the engine power loss rate for the same engine type and model in PNG operations may also be required by the Director, depending on the nature of the terrain, the lack of infrastructure and the scarcity of suitable aerodrome and safe forced landing areas, resulting in a higher risk. Both sets of power loss rates should be submitted to the Director for consideration.

6.6 EM Part 125.907

The Area Navigation System installed shall be a fully integrated system comprising two integrated avionics units integrating all navigation sensors, ADC, AHRS, autopilot, flight director system, engine/airframe condition monitoring system, weather radar, TAWS and Synthetic/Enhanced Vision System.

A navigation specification (RNAV 5 or RNP 5 e.g.), approved by CASA, details the performance required of an PBN system in terms of accuracy, integrity, availability and continuity; which navigation functionalities the RNAV/RNP system must have; which navigation sensors must be integrated into the RNAV/RNP system; and which requirements are placed on the flight crew.

Both RNAV and RNP specifications include requirements for certain navigation functionalities. At the basic level, these functional requirements may include:

(a) Continuous indication of aircraft position relative to track to be displayed to the pilot flying on a navigation display situated in his primary field of view;

(b) Display of distance and bearing to the active (To) waypoint;

(c) Display of ground speed or time to the active (To) waypoint;

(d) Navigation data storage function; and

(e) Appropriate failure indication of the RNAV system, including the sensors.

On-board performance monitoring and alerting is the main element that determines if the navigation system complies with the necessary safety level associated with an RNP application and provides the prime differentiation between RNP and RNAV; it relates to both lateral and longitudinal navigation performance; and it allows the flight crew to detect that the navigation system is not achieving, or cannot guarantee with 10^{-5} integrity, the navigation performance required for the operation.

The area navigation system shall be certificated as PBN (RNP and/or RNAV) capable.

6.7 EM Part 125.911

The proving flight is a demonstration that the operational support systems and the inflight operations can work together in real time to produce a safe operation, which complies with the legislation and applicant’s exposition. All training and written procedures for the operation must be complete and, if deemed necessary by the operator, practiced before the proving flight. The applicant should be made aware that this flight is not a dry run to find teething problems, but it is the final ‘dress rehearsal’ for the commencement of a SEIFR operations. If this flight is unsuccessful, it will need to be repeated.

It should be noted that proving flights must involve both CASA flight operations and airworthiness personnel as many aspects apply to both disciplines.

CAR Part 119.57 empowers the CASA to require the applicant to conduct proving flights or other aircraft tests or demonstrations of aircraft procedures. When proving flights are required, the CASA must give written notice to the applicant.

Proving flights must be conducted in all respects as if they were revenue services. Depending on the nature of the operation, more than one proving flight may be required. The following conditions apply to proving flights. Proving flights for SEIFR must cover at least three route sectors, with one sector preferably conducted at night.

For SEIFR proving flights, only the applicant's crew and CASA Inspectors shall be carried. Passengers are not permitted.

The first two route sectors of a SEIFR proving flight shall be flown in VMC and the third route sector may be flown in IMC/night at the discretion of the senior CASA inspector with the concurrence of the aircraft captain.

The following functions shall be demonstrated during SEIFR proving flights:

- Flight preparation including route selection, flight planning, awareness of PBN specifications, consideration of alternate aerodrome and safe forced landing areas appropriate to the route, use of route guide and consideration of emergency and contingency procedures.
- Loading and checking of RNAV/FMS, as appropriate.
- Consideration of meteorological information, including icing and convective weather possibility.
- Two pilot operational procedures and CRM, as applicable; or alternative single pilot operational procedures, as applicable.
- Awareness of enroute lowest safe altitude lowest safe altitudes to diversion aerodromes and safe forced landing areas.
- The management of simulated emergencies including engine power loss, icing procedures, diversion and forced landing procedures.
- The management of EVS/SVS/CVS/HUD, as appropriate, and the operational application of PBN.
- The use of weather and TAWS.
- Liaison and communication with ATS and the operator's operation control facility, if pertinent.
- Recording of the data, in respect of SEIFR operations, required by legislation.
- Application of the MEL.
- Defect reporting and the use of the Technical Log.

Deficiencies in compliance with procedures set out in the Exposition or regulatory requirements are to be expected during the proving flight. These will require rectification. Additional proving flights may not be required if the outcome of remedial action can be satisfactorily assessed by ground testing. If, however, in the opinion of the Senior FOI, the deficiencies are such that on- ground testing would not be appropriate, then the proving flight will be deemed to have failed and further proving flights will be necessary.

6.8 EM Part 125.915(a)(1)

(a) Given the potentially safety critical nature of SEIFR operations in PNG it has been determined that such operations shall be operated by a two-pilot crew to enable the crew to cope comfortably with a high workload and flight deck and navigation management in emergency situations or single pilot crew where equivalent safety can be demonstrated by an applicant under paragraph (c) below.

(b) It is vitally important that flight crew are trained in two pilot operations, flight deck management under such conditions and CRM. The training programme shall be included in the operator's Operations Manual and accepted by the Director.

(c) As an alternative to the two-pilot crew operation described above, an air operator may choose to operate with a single pilot crew in accordance with the minimum crew provision of rule 91.401. Under this provision, the pilot-in-command shall not operate an aircraft under IFR without another pilot, unless the following requirements are met:

(1) the aircraft flight manual authorises operation of the aircraft with one pilot; and

(2) the aircraft is equipped with:

(i) communication equipment that can be operated by the pilot without releasing the aircraft flight controls; and

(ii) an operative autopilot or stabilisation system capable of operating the aircraft controls to maintain flight and manoeuvre the aircraft about the roll and pitch axes with an automatic heading hold.

(d) The operator's SEIFR single-pilot operation training programme and operating procedures must be approved by the Director.

(e) The air operator shall ensure that each pilot-in-command satisfactorily completes a route and aerodrome check under the supervision of an authorized flight examiner for all representative SEIFR routes. Details of these representative SEIFR routes should be discussed and agreed with the CASA Flight Operations Inspector during the 5-phase initial SEIFR certification process.

6.9 EM Part 125.915(a)(4)

Suitable aerodrome in the SEIFR context means and aerodrome certificated under CAR Part 139 or a non-certificated aerodrome with minimum standards acceptable to the Director under CAR Part 139.15.

7. Acceptable Means of Compliance (AMC)

7.1 AMC Part 125.1(c)

When assessing the safety of SEIFR operations in PNG the operator shall consider and include in the Route Manual:

(f) A description of the seasonal weather influences, including adverse weather patterns, on each route, diversion routes and aerodromes and emergency landing sites and how flight crew and planners should best cope with such influences to ensure the safety of operations; and

(g) The safeguards and procedures to be undertaken when planning and operating SEIFR operations in IMC and/or at night.

(h) A description of the terrain and obstacles below and adjacent to each route and the expected impact on SEIFR operations in both normal operations and emergency situations.

7.2 AMC Part 125.1(d)

The operator shall conduct a risk assessment for each specific route in accordance with the basic requirements of CAR Part 100.61. In doing so the operator shall use the following methodology taking into account the aerodrome aspects as well as the difficulties associated with the route and the performance of the specific aeroplane type concerned. Risk analysis methods shall be described in the operator's Operations Manual. Risk mitigators should flow from this methodology.

(a) The methodology used should aim at estimating the likelihood of failing to achieve a successful landing in case of a power loss, a successful landing being defined as one with minimal injuries sustained;

(b) It should consist of generating a risk profile for a specific route, including departure, en-route and arrival aerodrome and runway, splitting the proposed flight into appropriate segments, and estimating the risk for each segment should the engine suffer a power loss in this segment. This risk profile is considered to be an estimation of the probability of an unsuccessful forced landing if the engine fails during one of the identified segment.

(c) When assessing the risk in each segment, the height of the engine power loss, the position relative to the departure or destination aerodrome or to an emergency landing area en route, as well as the likely ambient conditions (ceiling, visibility wind and light) should be taken into account

(d) The duration of each segment determines the exposure time at that estimated risk. By summing the risk for all individual segments, the cumulative risk for the flight due to engine power loss can be calculated and converted to a 'per flight hour' basis.

Note 1: *It is recommended that the paper "Risk Assessment for European Public Transport Operations using Single Engine Turbine Aircraft at Night and in IMC" be used in the conduct of route risk assessment. The paper was produced by QinetiQ for EASA. The paper is at Attachment 1 to this Advisory Circular.*

Note 2: *CASA PNG may review other route risk algorithms and methodology proposals by individual PNG air operators when applying for SEIFR approval, taking into consideration the length of each leg of the route which may vary from the above AMC Part 125.1(d) methodology.*

7.3 AMC Part 125.915(a)(3)

The operator shall provide a Route Manual, for the use of flight crew, which details the specific routes approved to be flown as a SE-IFR operation along with information on:

(a) The expected seasonal and diurnal weather variations and their expected impact on SE-IFR operations.

(b) Contingency procedures to assist with obstacle clearance in the event of engine power loss on take-off, landing and during an instrument approach and departure procedure enabling the aircraft to land with a statistically adequate level of safety on a runway or a suitable safe forced landing area.

(c) The name, location and accurate position of destination, alternate and emergency aerodromes and suitable safe forced landing areas on, and adjacent to, the route which could be used in the event of a power loss or other emergency requiring an immediate landing.

(d) The location of specific geographic positions along the route between which the aeroplane has an unimpeded glide to an identified safe forced landing area in the event of a power loss.

(e) Each segment or sub-segment of a specific route the operator shall ensure that adverse terrain and/or obstacles do not prevent an unimpeded glide to an emergency aerodrome or suitable safe forced landing area. The Route Guide shall clearly detail such assurance.

The aforementioned routes, contingency geographic positions, the position of diversion aerodromes and suitable safe forced areas shall be available in the aeroplane's area navigation system database and available for immediate use by flight crew when required. The operator shall ensure the required database is current and updated in accordance with the AIRAC revision schedule.

7.4 AMC Part 125.915(a)(4)

The Route Manual shall contain a map showing range circles, from a clearly identified suitable aerodrome, based on a flying time of 45 minutes, in still air, at the aeroplane's normal cruising speed, from that suitable aerodrome. The range circle map shall show each route and diversion route for the operator's current operation indicating the whole of each route is contained within 45 minute range circles.

Suitable aerodrome in the SEIFR context means and aerodrome certificated under CAR Part 139 or a non-certificated aerodrome with minimum standards acceptable to the Director under CAR Part 139.15.

7.5 AMC Part 125.915(a)(5)

The operator shall identify critical terrain and obstacles in the take-off and landing areas and the departure and arrival areas and between the enroute diversion points and suitable aerodromes and safe forced landing areas to provide reasonable assurance that the engine inoperative gliding profile from the point of engine power loss to the suitable aerodrome or suitable safe forced landing area is not compromised. The foregoing information shall be included in the operator's Route Manual.

7.6 AMC Part 125.915(a)(3), (4), (5) and (6)

The operator shall include in its Operations Manual and/or its Maintenance Control Manual, as applicable, details of a system in a database which records:

(a) Any event of potential risk to the safety of SEIFR operations; and

(b) The occasions when an aeroplane was not despatched on a SEIFR operation due to weather below alternate minima at the destination aerodrome and/or not VMC below route LSALT at diversion airports or emergency landing sites; and

(c) For each aeroplane, the maintenance of database designed to assess the reliability of the aeroplane and its systems; and

(d) Details of compliance with engine manufacturer's maintenance programme; and

(e) The recording of the number of flights operated each month; and

(f) Details of any diversion from a planned SEIFR operation; and

(g) The number of occasions when an aeroplane was not despatched on a SEIFR operation due to aeroplane unserviceability along with details of that unserviceability.

A review of the foregoing shall be undertaken monthly by a review team comprising the Head of Flight Operations and the Head of Maintenance Control or a suitable person appointed for that purpose by the

Chief Executive and acceptable to the Director. To avoid the possibility of conflict of interest the Quality Assurance Department shall not conduct the review as it normally conducts an audit of the processes and the actions of all concerned with these activities in accordance with its annual audit programme.

The review team of the Head of Flight Operations and the Head of Maintenance Control, or the suitable person appointed to conduct the review, shall ensure the aforementioned records and the results of the monthly review are provided to the Director each calendar month.

The foregoing activities shall be clearly described in the operator's Exposition.

7.7 AMC Part 125.917(1), (2), (3) and (4)

The following additional procedures shall be included within the operator's training programme required by Part 125.553:

(a) Engine failure or malfunction which necessitates an off-airport landing after take-off on the most suitable terrain in the vicinity of the aerodrome. These can be organised into a number of procedures, depending on the height of the aircraft at the time of the failure

(b) Engine failure or malfunction which necessitates turning to execute a glide landing upon a serviceable runway, including a 'turn-back' manoeuvre. This procedure is to contain a minimum indicated airspeeds, maximum angles of bank and altitudes

(c) Engine malfunction, during climb, cruise and descent and from the approach to land phase in VMC, IMC and night.

(d) Additional procedures for the conduct of a forced landing in IMC and/or night to ground level.

(e) The use of the Minimum Equipment List and the application of SEIFR specific procedures.

(f) Discussion on the contents of the Route Guide dealing with the specific SEIFR inclusions and their application in operational practice.

(g) The assessment of the possible impact of forecast icing conditions and the procedures for managing icing conditions encountered in flight and the means of minimising the adverse impact of icing.

(h) The use of area navigation systems for normal, abnormal and emergency operations.

(i) The principles and use on Performance Based Navigation in the PNG SEIFR context.

(j) Optimising the use of weather radar for adverse weather avoidance in areas of high terrain.

(k) The use of SVS, EVS and CVS, as appropriate to the aircraft fitment, in the SEIFR context for normal, abnormal and emergency operations.

(l) Recency requirements for flight crew members conduct SEIFR operations.

(m) The use of the HUMS (Health and Usage Monitoring System) and the flight crew responsibility for the recording, in the aeroplane Technical Log, each failure indicated in the cockpit by the HUMS.

7.8 AMC Part 125.917

Vision system training shall address all flight operations for which the vision system is to be utilised. This training shall include contingency procedures required in the event of system degradation or failure. Training for situational awareness should not interfere with other required operations. Training shall include the following elements as applicable:

(a) An understanding of the system characteristics and operational constraints;

(b) Normal procedures, controls, modes and system adjustments (e.g. sensor theory including radiant versus thermal energy and resulting images);

(c) Operational constraints, normal procedures, controls, modes and system adjustments;

(d) Limitations;

(e) Airworthiness requirements;

(f) Vision system display and use during low visibility operations, including taxi, take-off, instrument approach and landing; system use for instrument approach procedures in both day and night conditions;

(g) Failure modes and the impact of failure modes or limitations upon crew performance, in particular, for two-pilot operations;

(h) Crew coordination and monitoring procedures and pilot call-out responsibilities;

(i) Transition from enhanced imagery to visual conditions during runway visual acquisition;

(j) Rejected landing: with the loss of visual cues of the landing area, touchdown zone or rollout area;

(k) Any effects that weather, such as low ceilings and visibilities, may have on the performance of the vision system;

(l) Use of the visual system in normal, abnormal and emergency operations in the SEIFR context.

(m) The use and application of the MEL in respect of the HUD, SVS, EVS or CVS, as appropriate.

7.9 AMC Part 125.917

Performance based navigation training shall address all flight operations for which the area navigation system is to be utilised. Training shall include the following components:

(a) An understanding of the basic area navigation concepts and their application in the operator's route structure.

(b) An understanding of the area navigation system installed in the approved SEIFR aircraft and its inter-relationship with the aircraft systems.

(c) The operation of the area navigation system in normal, abnormal and emergency situations.

(d) Operational constraints and limitations.

(e) Airworthiness requirements.

(f) The relationship between RNAV and RNP in all phases of flight and how their use affects control procedures, separation, and phraseology.

(g) An understanding of the basic design methods and resulting lateral and vertical clearance from obstacles.

(h) An understanding of the principle involved with turns at a fly-by waypoint, a fly-over waypoint, a turn at an altitude/height and a fixed radius turn.

(i) An understanding of the legislation authorising and supporting PBN.

(j) Flight planning in the PBN context.

(k) Failure modes and the impact of failure modes or limitations upon crew performance, in particular, for two-pilot operations.

(l) Crew coordination and monitoring procedures and pilot call-out responsibilities.

(m) Contingency procedures in the event of a malfunction resulting in an inability to maintain the required lateral and/or vertical obstacle clearance.

(n) Contingency procedures in the event of area navigation system alerts.

(o) Procedures for monitoring the inflight performance of the area navigation system when using RNAV and RNP, the support of raw data and the actual navigation performance (ANP) of the system against the RNP for the operation.

(p) Database update and the AIRAC cycle.

(q) The use and application of the MEL in respect of the area navigation system in respect of its use for RNAV and/or RNP, as appropriate.

8. CASA Approval Process

8.1 The following outlines the processes and procedures to be undertaken by CASA when an applicant seeks approval to carry out SEIFR operations under a PNG AOC. The Director may vary the procedures outlined hereunder, at his discretion, depending on the applicant's overall experience in PNG and the operator's safety and compliance record.

8.2 For information, other regulators have approved the following aircraft types for SEIFR operations, when appropriately equipped:

- Cessna Model 208
- Pilatus PC12
- Socata TBM-700 (including TBM-850)

8.3 Regulatory Process

The applicant for SEIFR approval shall normally be the holder of a current PNG AOC. This means the application will be assessed as a variation to the existing AOC.

Under such circumstances, the processes and procedures outlined at Chapter 4 of the CASA Flying Operations Procedures Manual shall be followed.

The phases of AOC application assessment at Chapter 4.5.1 shall be followed. These are:

- Pre-application phase.
- Formal application phase.
- Document evaluation phase.
- Inspection and proving flight phase.
- Approval and AOC variation phase.

8.4 Specific Aspects to be checked by CASA for SEIFR Approval

8.4.1 Documentation

Applicants requesting approval to conduct SEIFR operations must provide the following information:

- The type of proposed air operations under CAR Part 125 (passenger, cargo or both).
- The aeroplane manufacturer.
- Aeroplane type and model.
- Aeroplane serial number.
- Aeroplane registration mark (if known)
- Aeroplane type certification status

- Evidence the aeroplane complies with all applicable requirements of CAR Part 125 and the acceptable means of compliance (AMC) outlined in AC125-3 or a proposed alternative means of compliance.
- Documents referenced in, or required to support, the compliance matrix.

8.4.2 Document Inspection

CASA Inspector shall verify at least the following matters have been included:

- Company SEIFR operational carrying limitations
- Requirement for passengers to occupy seats that meet the crashworthiness standards specified in FAR 23.562 and FAR 23.785 or later versions.
- SEIFR emergency procedures for take-off, climb, cruise and descent and runway specific procedures.
- Routes used for SEIFR operations, showing the procedures used for its design such as minimum altitude and tracking details.
- Procedures for the use of other than automatic engine ignition systems.
- Procedures to be followed by the pilot in command in the event of a chip detector warning.
- Procedures to be followed by the pilot in command in the event of a fire warning in all phases of flight.
- MEL, including SEIFR requirements and procedures.
- Procedures in the event of the pilot recognising an engine performance parameter has been exceeded.
- Procedures for the occurrence of a potential malfunction at various speeds on runways of varying length
- Aerodrome charts are to contain advice about areas to be avoided, if any, in the event of a forced landing.
- Guidance for the pilot in command in route selection, including considerations of terrain, weather, lowest safe altitude and diversion points in the event of power loss.

8.4.3 Training and Checking

CASA shall verify that for SEIFR operators the following additional procedures are included within the training and checking manual:

- Engine failure or malfunction which necessitates stopping the aircraft on the ground.
- Engine failure or malfunction which necessitates an off-airport landing after take-off on the most suitable terrain in the vicinity of the aerodrome. These can be organised into a number of procedures, depending on the height of the aircraft at the time of the failure
- Engine failure or malfunction which necessitates turning to execute a glide landing upon a serviceable runway, including a 'turn-back' manoeuvre. This procedure is to contain a minimum indicated airspeeds and altitudes.
- Engine malfunction, during climb, cruise and descent and from the approach to land phase in VMC and IMC.
- Additional procedures for the conduct of a forced landing in IMC to ground level.

8.4.4 Route Limitations

CASA shall verify the applicant's SEIFR routes are within 45 minutes flying time, in still air at normal cruising speed of a suitable aerodrome.

Suitable aerodrome in the SEIFR context means and aerodrome certificated under CAR Part 139 or a non-certificated aerodrome with minimum standards acceptable to the Director under CAR Part 139.15.

On application by the operator, CASA may approve SEIFR routes that do not meet the preceding requirements if they are over generally benign terrain. Such applications must be accompanied by a comprehensive risk analysis. The general nature of the terrain surrounding the route must be such that it could reasonably be assumed that a successful forced landing resulting in minimal injury to the aeroplane's occupants could be executed during the time of the proposed operation.

CASA may impose additional restrictions on particular routes. Factors that are to be considered by CASA include:

- Seasonal influences,
- The conduct of operations at night,
- Adverse weather patterns.
- Nature of the terrain below or in the proximity of the route used in the operation

8.4.5 Maintenance Control and System of Maintenance

For SEIFR operations, CASA shall verify the Maintenance Control Manual includes:

- The appointment of a maintenance controller, approved by CASA, to control the aeroplane's maintenance.
- A CAR Part 145 approved maintenance organisation.
- Responsibilities of the CAR Part 145 organisation in relation to the carrying out of SEIFR maintenance, including the requirement to train and maintain a register of staff who are authorised to release SEIFR to service.
- The engine and engine component condition trend monitoring procedures, including:
  - the training and qualification requirements for persons carrying out trend monitoring, and
  - the requirement that Engine Trend Monitoring shall only be accessed and interpreted by an appropriately trained person in accordance with the engine manufacturer's published data and at intervals not exceeding ten flight hours.

For SEIFR operations, CASA shall verify that the approved system of maintenance includes:

- The aeroplane manufacturer's maintenance schedule and any CASA approved deviations.
- An approved aeroplane, engine, propeller and component reliability monitoring program.
- Procedures to be carried out in response to parameters recorded by that reliability program.
- Procedures for the maintenance of SEIFR approved requirements.
- Procedures for engine chip detection contamination indication.
- Procedures in response to:
  - exceeding an engine performance parameter
  - an engine oil particle contamination indication
  - an inadvertent engine shutdown and relight event

When required, procedures for servicing the aeroplane's prime electrical source storage battery(s) in accordance with the battery manufacturer's published data.

8.4.6 Reliability Programme

CASA shall verify the reliability programme program covers the aircraft engine, propeller and equipment required to conduct an SEIFR operation and procedures exist such that when a component or system is reported to have suffered a loss of performance or failure, the Maintenance Controller or designated representative(s) assesses service data, including service bulletins and maintenance and operational information issued by the aeroplane and component manufacturers to determine whether the maintenance system requires amendment.

CASA shall verify, where an assessment identifies a component or system is the subject of a premature failure or loss of performance, procedures exist requiring the Maintenance Controller to ensure that the following is undertaken:

- a special inspection of the component or system, and
- taking into consideration the type of failure or loss of performance and the time in service at which the failure or loss of performance occurred, and
- analysis and record inspection of the performance criteria of the component or system to establish a benchmark for ongoing inspections or component replacement, and
- the timely replacement of components where required
- results are made available to CASA and the aircraft manufacturer
- where the programme identifies a component or system as being subject to a high rate of failure or loss of performance, the Maintenance Controller is required to report that assessment in writing to CASA and the aircraft manufacturer within five working days.

8.4.7 Document Assessment

CASA shall review all documentation submitted by the applicant to ensure it meets the assessment criteria outlined in the legislation and supporting advisory circular. If at any stage during the assessment process it becomes clear the documentation does not meet the required standard, CASA shall advise the applicant in writing. Further assessment of the application is discontinued.

CASA shall verify the procedures and additional documentation provided are appropriate given the nature of the SEIFR operations to be covered by the AOC.

8.4.8 Final Inspection and Proving Flight

After all documentation is declared acceptable and/or approved by the Director the final phase leading to the SEIFR approval is conducted.

Facilities pertinent to the SEIFR operation shall be inspected and verified followed by an inspection of the specific aeroplane type to confirm the aircraft and its equipment meets all pertinent requirements.

CASA Inspector shall verify, both pre-flight and in-flight, that all documented SEIFR procedures (normal, abnormal and emergency) are appropriate and able to be complied with. Proving flights shall be required and conducted in accordance with EM Part 125.911 above.