**United Kingdom** **Overseas Territories Aviation Circular**

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# Commercial Air Transport Operations with Single-Engine Turbine Aeroplane Operations at Night and/or in Instrument Meteorological Conditions (SET-IMC)

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## GENERAL

Overseas Territories Aviation Circulars are issued to provide advice, guidance and information on standards, practices and procedures necessary to support Overseas Territory Aviation Requirements. They are not in themselves law but may amplify a provision of the Air Navigation (Overseas Territories) Order or provide practical guidance on meeting a requirement contained in the Overseas Territories Aviation Requirements.

## PURPOSE

The purpose of this Overseas Territories Aviation Circular is to provide information regarding commercial air transport operations with Single-Engine Turbine Aeroplane Operations at Night and/or in Instrument Meteorological Conditions (SET-IMC) and the requirements of the AN(OT)O and OTAR Parts 121, 135 and 39 for obtaining an approval. This guidance is also intended to provide an indication of the level of knowledge and investment in resources necessary, before an operator is ready to commence the process of applying for a SET-IMC approval.

## RELATED REQUIREMENTS

This Circular relates to OTAR Parts 91, 135,121 and 39.

## CHANGE INFORMATION

First issue.

## ENQUIRIES

Enquiries regarding the content of this Circular should be addressed to Air Safety Support International at the address on the ASSI website www.airsafety.aero or to the appropriate Overseas Territory Aviation Authority.

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# Abbreviations and Acronyms

| | |
|---|---|
| AN(OT)O | Air Navigation (Overseas Territories) Order |
| IFR | Instrument Flight Rules |
| IMC | Instrument Meteorological Conditions |
| MEL | Minimum Equipment List |
| OTAA | Overseas Territory Aviation Authority |
| OTAR | Overseas Territories Aviation Requirements |
| SET-IMC | Single-Engine Turbine Aeroplane Operations at Night and /or in Instrument Meteorological Conditions |
| STC | Supplemental Type Certificate |
| TC | Type Certificate |
| VFR | Visual Flight Rules |

### Definitions

### Risk Period

With regards to SET-IMC, a Risk Period is a period of flight during which no landing site has been identified and/or selected by an operator.

### Hostile Environment

‘Hostile environment’ means:

(a) an environment in which:

- (i) a safe forced landing cannot be accomplished because the surface is inadequate;
- (ii) search and rescue response/capability is not provided consistent with anticipated exposure; or
- (iii) there is an unacceptable risk of endangering persons or property on the ground.

(b) In any case, the following areas shall be considered hostile:

- (i) for overwater operations, the open sea areas North of 45N and South of 45S; and
- (ii) those parts of a congested area without adequate safe forced landing areas.

# 1. Introduction

1.1 The Air Navigation (Overseas Territories) Order requires that a single-engine turbine aeroplane must not fly for the purpose of commercial air transport at night and/or in Instrument Meteorological Conditions (IMC), unless it is operating under and in accordance with an approval issued by the relevant OTAA.

1.2 For Territory-registered aircraft, an approval is only issued when the operator has proven compliance with the requirements of OTAR Parts 135 or 121 (Part SPA Section V, Single-Engine Turbine Aeroplane Operations at Night and/or in Instrument Meteorological Conditions (SET-IMC)). This requires that the operator satisfies the following:

a) demonstrate an acceptable level of turbine engine reliability in the world fleet for the relevant engine-airframe combination; and

b) establish specific maintenance instructions and procedures; and

c) establish an engine trend monitoring programme; and

d) establish a propulsion and systems reliability programme; and

e) establish and maintain a flight crew composition and training/competency checking programme for the flight crew member(s) involved in these operations; and

f) complete a safety risk assessment for the operation; and

g) establish operating procedures specifying:

(i) the equipment to be carried, including its operating limitations and appropriate entries in the Minimum Equipment List (MEL);
(ii) flight planning;
(iii) normal procedures;
(iv) contingency procedures;
(v) monitoring and incident reporting.

# 2. Turbine Engine Reliability

2.1 The operator should obtain the power plant reliability data from the type certificate (TC) holder and/or supplemental type certificate (STC) holder.

2.2 The data for the engine-airframe combination should have demonstrated, or be likely to demonstrate, a power loss rate of less than 10 per million flight hours. Power loss in this context is defined as any loss of power, including in-flight shutdown, the cause of which may be traced to faulty engine or engine component design or installation, including design or installation of the fuel ancillary or engine control systems.

2.3 The in-service experience with the intended engine-airframe combination should be at least 100 000 hours, demonstrating the required level of reliability. If this experience has not been accumulated, then, based on analysis or test, in-service experience with a similar or related type of airframe and turbine engine might be considered by the TC/STC holder to develop an equivalent safety argument in order to demonstrate that the reliability criteria are achievable.

# 3. Maintenance and Reliability Programme

3.1 The following maintenance aspects should be addressed by the operator:

a) Engine monitoring Programme

(i) The operator's maintenance programme should include an oil-consumption-monitoring programme that should be based on engine manufacturer's recommendations, if available, and track oil consumption trends. The monitoring should be continuous and take account of the oil added. An engine oil analysis programme may also be required if recommended by the engine manufacturer. The possibility to perform frequent (recorded) power checks on a calendar basis should be considered.

(ii) The engine monitoring programme should also provide for engine condition monitoring describing the parameters to be monitored, the method of data collection and a corrective action process and should be based on the engine manufacturer's instructions. This monitoring will be used to detect propulsion system deterioration at an early stage allowing corrective action to be taken before safe operation is affected.

b) Propulsion and associated systems' reliability Programme

(iii) A propulsion and associated systems' reliability programme should be established, or the existing reliability programme supplemented for the engine-airframe combination. This programme should be designed to early identify and prevent problems, which otherwise would affect the ability of the aeroplane to safely perform its intended flight. Where the fleet of SET-IMC aeroplanes is part of a larger fleet of the same engine-airframe combination, data from the operator's total fleet should be acceptable.

(iv) For engines, the programme should incorporate reporting procedures for all significant events. This information should be readily available (with the supporting data) for use by the operator, TC/STC holders, and the relevant OTAA to help establish that the reliability level, set out in section 2 of this OTAC, is achieved. Any adverse trend would require an immediate evaluation to be conducted by the operator in consultation with its competent authority. The evaluation may result in taking corrective measures or imposing operational restrictions.

(v) The engine reliability programme should include, as a minimum, the engine hours flown in the period, the power loss rate for all causes, and the engine removal rate, both rates on an annual basis, as well as reports with the operational context focusing on critical events. These reports should be communicated to the TC/STC holders and the OTAA.

(vi) The actual period selected should reflect the global utilisation and the relevance of the experience included (e.g. early data may not be relevant due to subsequent mandatory modifications that affected the power loss rate). After the introduction of a new engine variant and whilst global utilisation is relatively low, the total available experience may have to be used to try to achieve a statistically meaningful average.

# 4. Flight Crew Training, Competency, Composition and Experience

4.1 The operator's flight crew training and competency checking programme, established in accordance with OTAR Parts 135 & 121 SubParts I and J, should incorporate the following elements:

4.2 **Conversion training**, which should be conducted in accordance with a syllabus devised for SET-IMC operations and include at least the following:

a) Normal Procedures:

(i) anti-icing and de-icing systems operation;

(ii) navigation system procedures;

(iii) radar positioning and vectoring, when available;

(iv) use of radio altimeter; and use of fuel control, displays interpretation

b) Abnormal Procedures

(i) anti-icing and de-icing systems failures;

(ii) navigation system failures;

(iii) pressurisation system failures;

(iv) electrical system failures; and engine-out descent in simulated IMC;

c) Emergency Procedures

(i) engine failure shortly after take-off;

(ii) fuel system failures (e.g. fuel starvation);

(iii) engine failure other than the above: recognition of failure, symptoms, type of failure, measures to be taken, and consequences;

(iv) depressurisation; and

(v) engine restart procedures:

a. choice of an aerodrome or landing site; and
b. use of an area navigation system;

(vi) air traffic controller (ATCO) communications;

(vii) use of radar positioning and vectoring (when available);

(viii) use of radio altimeter; and

(ix) practice of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power.

4.3 **Competency checking**, following conversion training, should contain the following items, as part of the Operator's Proficiency Check:

a) conduct of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power;

b) engine restart procedures;

c) depressurisation following engine failure; and

d) engine-out descent in simulated IMC.

4.4 **Use of simulator** (for conversion training and checking)

Where a suitable full flight simulator (FFS) or a suitable flight simulation training device (FSTD) is available, it should be used to carry out conversion training on the items under (4.2) and competency checking of the items under (4.3) above.

4.5 **Recurrent training**

Recurrent pilot training for SET-IMC operations should be included, as required by OTAR Parts 135.950(a)(6) & 121.950(a)(6). This training should include all items under 4.1 above.

4.6 **Recurrent competency checking**

The following items should be included in the list of required items to be checked as part of the OPC:

a) conduct of the forced landing procedure until touchdown in simulated IMC, with zero thrust set, and operating with simulated emergency electrical power;

b) engine restart procedures;

c) depressurisation following engine failure; and

d) emergency descent in simulated IMC.

4.7 **Use of simulator** (recurrent training and competency checking)

Following conversion training and competency checking, the next recurrent training session and OPCs, including SET-IMC operations items, should be conducted in a suitable FFS or FSTD, where available.

4.8 **Crew composition**

Crew composition for commercial air transport flights, should be in accordance with Article 41 of the AN(OT)O, the operator's operations manual and para 4.9 below.

4.9 **Crew experience**

a) The pilot-in-command should have a minimum of 700 hours of flight time on aeroplanes, including 400 hours as pilot-in-command and 100 hours under IFR. The 400 hours as pilot-in-command may be substituted by hours operating as co-pilot within an established multi-pilot crew system prescribed in the operations manual, on the basis of two hours of flight time as co-pilot for one hour of flight time as pilot-in command.

b) If the pilot-in-command has less than 100 hours under Instrument Flight Rules (IFR), with the relevant type or class of aeroplane, including line flying under supervision, the aeroplane should carry at least two pilots.

c) A lesser number of flight hours under IFR on the relevant type or class of aeroplane may be acceptable to the OTAA, when the flight crew member has significant IFR experience.

# 5. Route Planning

## 5.1 Flight Planning

a) The operator should establish flight planning procedures to ensure that the routes and cruising altitudes are selected so that a landing site is within gliding range.

b) Notwithstanding (a) above, whenever a landing site is not within gliding range, one or more risk periods may be used for the following operations:

(i) over water; or

(ii) over a hostile environment; or

(iii) over congested areas.

Except for the take-off and landing phase, the operator should ensure that when a risk period is planned, there is a possibility to glide to a non-congested area.

The total duration of the risk period per flight should not exceed 15 minutes unless the operator has established, based on a risk assessment carried out for the route concerned, that the cumulative risk of fatal accident due to an engine failure for this flight remains at an acceptable level (see para 7).

c) The operator should establish criteria for the assessment of each new route. These criteria should address the following:

(i) the selection of aerodromes along the route;

(ii) the identification and assessment, at least on an annual basis, of the continued suitability of landing sites (obstacles, terrain, dimensions of the landing area, type of the surface, slope, etc.) along the route when no aerodrome is available; the assessment may be performed using publicly available information or by conducting on-site surveys;

(iii) assessment of en route specific weather conditions that could affect the capability of the aeroplane to reach the selected forced landing area following loss of power (icing conditions including gliding descent through clouds in freezing conditions, headwinds, etc.);

(iv) consideration of landing sites' prevailing weather conditions, to the extent that such information is available from local or other sources; expected weather conditions at landing sites for which no weather information is available should be assessed and evaluated, taking into account a combination of the following information:

(1) local observations

(2) regional weather information (e.g. significant weather charts); and

(3) terminal area forecast (TAF)/meteorological aerodrome report (METAR) of the nearest aerodromes; and

(v) protection of the aeroplane occupants after landing in case of adverse weather.

d) At the flight planning phase, any selected landing site should have been assessed by the operator as acceptable for carrying out a safe forced landing with a reasonable expectation of no injuries to persons in the aeroplane or on the ground. All information reasonably practical to acquire should be used by the operator to establish the characteristics of landing sites.

e) Landing sites suitable for a diversion or forced landing should be programmed into the navigation system so that track and distance to the landing sites are immediately and continuously available. None of these pre-programmed positions should be altered in-flight.

### 5.2 Route and Instrument Procedure Selection

The following should be considered by the operator, depending on the use of a risk period:

a) Departure

The operator should ensure, to the extent possible, that the instrument departure procedures to be followed are those guaranteeing that the flight path allows, in the event of power loss, the aeroplane to land on a landing site.

b) Arrival

The operator should ensure, to the extent possible, that the arrival procedures to be followed are those guaranteeing that the flight path allows, in the event of power loss, the aeroplane to land on a landing site.

c) En Route

The operator should ensure that any planned or diversionary route should be selected and be flown at an altitude such that, in the event of power loss, the pilot is able to make a safe landing on a landing site.

5.3 **Landing Site**

A landing site is an aerodrome or an area where a safe forced landing can be performed by day or by night. The following should be taken into account:

a) The landing site should allow the aeroplane to completely stop within the available area, taking into account the slope and the type of the surface.

b) The slope of the landing site should be assessed by the operator in order to determine its acceptability and possible landing directions.

c) Both ends of the landing area, or only the zone in front of the landing area for one-way landing areas, should be clear of any obstacle which may be a hazard during the landing phase.

d) The expected weather conditions at the time of the foreseen landing, including ceiling, visibility, wind and light.

# 6. Route Limitations over Water

In the event of an engine failure, a single engine aeroplane operating under OTAR Parts 135 or 121, shall be capable of reaching a place at which a safe forced landing can be made. For landplanes, a place on land is required unless otherwise approved by the OTAA.

# 7. Safety Risk Assessment

The risk assessment methodology should aim at estimating for a specific route the likelihood of having fatalities due to emergency landing caused by engine failure. Based on the outcome of this risk assessment, the operator may extend the duration of the risk period beyond the maximum allowed duration if no landing site is available within gliding range.

a) The Safety Target

(i) The overall concept of SET-IMC operations is based on an engine reliability rate for all causes of 10 per million flight hours, which permits in compliance with SET-IMC requirements an overall fatal accident rate for all causes of 4 per million flight hours.

(ii) Based on accident databases, it is considered that the engine failure event does not contribute by more than 33 % to the overall fatal accident rate. Therefore, the purpose of the risk assessment is to ensure that the probability of a fatal accident for a specific flight following engine failure remains below the target fatal accident rate of $1.3 \times 10^{-6}$.

b) Methodology

(i) The methodology aims at estimating the likelihood of failing to achieve a safe forced landing in case of engine failure, a safe forced landing being defined as a landing on an area for which it is reasonably expected that no serious injury or fatalities will occur due to the landing even though the aeroplane may suffer extensive damage.

(ii) This methodology consists of creating a risk profile for a specific route, including departure, en route and arrival airfield and runway, by splitting the proposed flight into appropriate segments (based on the flight phase or the landing site selected), and by estimating the risk for each segment should the engine fail in one of these segments. 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 segments.

(iii) When assessing the risk for each segment, the height of the aeroplane at which the engine failure occurs, the position relative to the departure or destination airfield or to an emergency landing site en route, and the likely ambient conditions (ceiling, visibility, wind and light) should be taken into account, as well as the standard procedures of the operator (e.g. U-turn procedures after take-off, use of synthetic vision, descent path angle for standard descent from cruising altitude, etc.).

(iv) The duration of each segment determines the exposure time to the estimated risk. The risk is estimated based on the following calculation:

*Segment risk factor = segment exposure time (in s)/3 600 × probability of unsuccessful forced landing in this segment x assumed engine failure rate per flight hour (FH).*

(v) By summing up the risks for all individual segments, the cumulative risk for the flight due to engine failure is calculated and converted to risk on a 'per flight hour' basis.

(vi) This total risk must remain below the target fatal accident rate of 1.3 × 10-6 as under (b) above.

c) Example of a risk assessment

(i) An example of such a risk assessment is provided in Appendix A. In any case, this risk assessment is an example designed for a specific flight with specific departure and arrival aerodrome characteristics. It is an example of how to implement this methodology, and all the estimated probabilities used in the table below may not directly apply to any other flight.

(ii) The meaning of the different parameters used is further detailed below:

(iii) AD/Other: 'AD' is ticked whenever only aerodromes are selected as landing sites in the segment concerned. 'Other' is ticked if the selected landing sites in the segment concerned are not aerodromes. When a risk period is used by the operator, none of the two boxes (neither 'AD' nor 'Other') are ticked.

(iv) Segment exposure time: this parameter represents the duration of each segment in seconds (s).

(v) <u>Estimated probability of an unsuccessful forced landing if engine fails in the segment</u>: probability of performing in the segment a safe forced landing following engine power loss.

(vi) <u>Segment risk factor</u>: risk of an unsuccessful forced landing (because of power loss) per segment (see formula above).

# 8. Event Reporting

An operator approved for SET-IMC operations shall report all significant failures, malfunctions or defects to the OTAA.

# 9. Obtaining an Approval

For details on the process for applying for a SET-IMC approval, operators will need to contact the relevant OTAA.

**END**

# APPENDIX A

## Example Risk Assessment for SET-IMC

| | | LANDING SITE | | | | Assumed engine failure rate per FH | | | $1,00x10^{-5}$ |
|---|---|---|---|---|---|---|---|---|---|
| **Segments of flight** | **Assumed height or height band above ground level (AGL) in ft** | **AD** | **Other** | **Segment exposure time (in s)** | **Cumulative flight time from start of take-off to end of segment (in s)** | **Estimated probability of unsuccessful forced landing if engine fails in this segment** | **Segment risk factor** | **Cumulative risk per flight** | **Comment on estimation of unsuccessful outcome** |
| Take-off (T-O) ground roll | 0 ft | X | | 20 | 20 | 0.01 % | $5.56 \times 10^{-12}$ | $5.56 \times 10^{-12}$ | T-O aborted before being airborne. Runway long enough to stop the aircraft. |
| Climb-out | 0-50 ft | X | | 8 | 28 | 0.10 % | $2.22 \times 10^{-11}$ | $2.78 \times 10^{-11}$ | Aircraft aborts T-O and lands ahead within runway length available. |
| | 50-200 ft | X | | 10 | 38 | 1.00 % | $2.78 \times 10^{-10}$ | $3.06 \times 10^{-10}$ | |
| | 200-1 100 ft | | | 36 | 74 | 100.00 % | $1.00 \times 10^{-7}$ | $1.00 \times 10^{-7}$ | Aircraft has to land ahead outside airfield with little height for manoeuvring. |
| | 1 100-2 000 ft | X | | 36 | 110 | 50.00 % | $5.00 \times 10^{-8}$ | $1.50 \times 10^{-7}$ | U-turn and landing at opposite q-code for magnetic heading of a runway (QFU) possible. |
| | 2 000-4 000 ft | X | | 80 | 190 | 25.00 % | $5.56 \times 10^{-8}$ | $2.06 \times 10^{-7}$ | |
| Climbing to en route height | 4 000-10 000ft | X | X | 240 | 430 | 5.00 % | $3.33 \times 10^{-8}$ | $2.39 \times 10^{-7}$ | Aircraft able to operate a glide- in approach. |
| Cruising: emergency area available | ≤ 10 000 ft | X | | 5 400 | 5 830 | 5.00 % | $7.50 \times 10^{-7}$ | $9.89 \times 10^{-7}$ | En route cruising time with available landing sites along the route within gliding range. |
| Cruising: emergency area NOT available | ≤ 10 000 ft | | | 300 | 6 130 | 100.00 % | $8.33 \times 10^{-7}$ | $1.82 \times 10^{-6}$ | En route cruising time without available landing sites within gliding range. |
| Descent to initial approach fix for instrument flight rules (IFR) approach | 10 000-4 000 ft on a 4° slope (1 200 ft/min) | X | | 300 | 6 430 | 5.00 % | $4.17 \times 10^{-8}$ | $1.86 \times 10^{-6}$ | Descent with available landing sites within gliding range, and destination not reachable. |

| | | LANDING SITE | | | | Assumed engine failure rate per FH | | | $1,00 \times 10^{-5}$ |
|---|---|---|---|---|---|---|---|---|---|
| **Segments of flight** | **Assumed height or height band above ground level (AGL) in ft** | **AD** | **Other** | **Segment exposure time (in s)** | **Cumulative flight time from start of take-off to end of segment (in s)** | **Estimated probability of unsuccessful forced landing if engine fails in this segment** | **Segment risk factor** | **Cumulative risk per flight** | **Comment on estimation of unsuccessful outcome** |
| Aircraft has to descend below the glide approach capability to set up for a normal powered landing from 1 000 ft on a 3° approach path | 4 000-1 000 ft on the approach | | X | 150 | 6 580 | 50.00 % | $2.08 \times 10^{-7}$ | $2.07 \times 10^{-6}$ | Aircraft descends below the height needed to maintain a glide approach for reaching the airfield. Therefore, it may land short of airfield if engine fails. |
| Aircraft descends on a 3° approach path | 1 000 -50 ft on approach at 120 kt (600 ft/min) | | | 95 | 6 675 | 100.00 % | $2.64 \times 10^{-7}$ | $2.34 \times 10^{-6}$ | Aircraft assumes 3° glideslope, regained to ensure normal landing. Therefore, it may undershoot the landing field if engine fails at this late stage. |
| Landing | 50 ft above threshold until touchdown | X | | 10 | 6 685 | 5.00 % | $1.39 \times 10^{-9}$ | $2.34 \times 10^{-6}$ | Aircraft over runway. Engine is to be idled anyway, but failure, while airborne, may surprise pilot and result in hard landing. |
| Landing ground run | Touchdown to stop | X | | 15 | 6 700 | 0.01 % | $4.17 \times 10^{-12}$ | $2.34 \times 10^{-6}$ | Aircraft on ground. Risk negligible, if engine stops on the example runway (very long) providing that all services are retained. |
| | | **Cumulative flight time (min)** | | | | | Risk per flight | **$1.26 \times 10^{-6}$** | |
| | | **Max risk period (min)** | | | | | Max target | | |

# PROBABILITY TABLE

The following Table may be used to determine the estimated probability of an unsuccessful forced landing:

| PROBABILITY (%) | DESCRIPTION |
|---|---|
| 0 | IMPOSSIBLE |
| 0 – 1 | NEGLIGIBLE |
| 1 – 10 | POSSIBLE BUT NOT LIKELY |
| 10 – 35 | MODERATELY LIKELY |
| 35 – 65 | POSSIBLE |
| 65 – 90 | LIKELY |
| 90 – 99 | ALMOST CERTAIN |
| 99 - 100 | CERTAIN |