Notice of Proposed Amendment 2014-18

Commercial air transport aeroplane operations at night or in IMC using single-engined turbine aeroplane

RMT.0232 & RMT.0233 (MDM.031(A)&(B)) — 17.7.2014

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses several issues in the environmental, economic, and regulatory coordination domains related to commercial air transport operations using single-engined aeroplane at night/in IMC (CAT SET-IMC).

This NPA is linked to amendment 29 to ICAO Annex 6, applicable since 2005, which provided SARPs for CAT SET-IMC operations and which has not yet been transposed in the EU regulatory framework.

The specific objective is to allow CAT SET-IMC operations in Europe through cost-efficient rules which mitigate the risks linked to an engine failure to a level comparable with similar operations with twin-engined aeroplanes.

This NPA proposes new provisions specifically drafted for CAT SET-IMC, which amend Annex II, IV and Annex V to Regulation (EU) No 965/2012.

The proposed changes are expected to maintain safety, improve harmonisation and ensure ICAO compliance.

Applicability		Process map	
Affected regulations and decisions:	Annexes II, IV and V to Regulation (EU) No 965/2012 Decision 2012/016/R Decision 2012/017/R Decision 2012/019/R	Concept Paper:	No
		Terms of Reference:	13.11.2012
		Rulemaking group:	Yes
		RIA type:	Full
Affected stakeholders:	Operators and NAAs	Technical consultation during NPA drafting:	No
Driver/origin:	Transfer of a JAA task Proportionality Transposition of ICAO standards	Duration of NPA consultation:	3 months
		Review group:	Yes
		Focussed consultation:	No
		Publication date of the Opinion:	Q3/2015
Reference:	JAA NPA OPS 29 Rev 2 QINETIQ report QINETIQ/EMEA/IX/CR0800029/2 'Risk assessment for European Public Transport Operations using Single Engine Turbine Aircraft at Night and in IMC'	Publication date of the Decision:	Q3/2016

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1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this Notice of Proposed Amendment (NPA) in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2].

This rulemaking activity is included in the Agency's Rulemaking Programme 2014-2017 under RMT.0232/0233 (former task number MDM.031(a)&(b))[3].

The text of this NPA has been developed by the Agency based on the input of the Rulemaking Group RMT.0232/0233. It is hereby submitted for consultation of all interested parties[4].

1.2. The structure of this NPA and related documents

Chapter 1 of this NPA contains the procedural information related to this task. Chapter 2 (Explanatory Note) explains the core technical content. Chapter 3 contains the proposed text for the new requirements. Chapter 4 contains the Regulatory Impact Assessment showing which options were considered and what impacts were identified, thereby providing the detailed justification for this NPA.

1.3. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

The deadline for submission of comments is **17 October 2014.**

1.4. The next steps in the procedure

Following the closing of the NPA public consultation period, the Agency will review all comments.

The outcome of the NPA public consultation will be reflected in the respective Comment-Response Document (CRD).

The Agency will publish the CRD either as a separate document or together with the Opinion with a prior focussed consultation.

The Opinion contains proposed changes to EU regulations and it is addressed to the European Commission, which uses it as a technical basis to prepare a legislative proposal.

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1 Regulation (EC) No 216/2008 of the European Parliament and the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1), as last amended by Commission Regulation (EU) No 6/2013 of 8 January 2013 (OJ L 4, 9.1.2013, p. 34).

2 The Agency is bound to follow a structured rulemaking process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as the 'Rulemaking Procedure'. See Management Board Decision concerning the procedure to be applied by the Agency for the issuing of Opinions, Certification Specifications and Guidance Material (Rulemaking Procedure), EASA MB Decision No 01-2012 of 13 March 2012.

3 http://easa.europa.eu/agency-measures/docs/agency-decisions/2013/2013-023-R/Final %204-year %20Rulemaking %20Programme %202014-2017.pdf.

4 In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

5 In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

The Decision containing Acceptable Means of Compliance (AMC) and Guidance Material (GM) will be published by the Agency when the related Implementing Rule(s) are adopted by the Commission.

2. Explanatory Note

2.1. Overview of the issues to be addressed

The main issues that are covered by this NPA are the following:

- A level playing field issue since some Member States currently allow some of their operators to operate CAT SET-IMC flights under an exemption to EU-OPS. These exemptions are based on different sets of conditions (ICAO Annex 6 or JAA NPA OPS 29 Rev 2) which prevents a level playing field amongst operators allowed to operate CAT SET-IMC. It should be noted as well that EU operators are, in addition, facing competition from TCO operators allowed by their authorities to operate CAT SET-IMC.
- An ICAO alignment issue since ICAO SARPs allowing CAT SET-IMC are applicable since 2005.
- An harmonisation issue since some other major foreign aviation authorities (FAA, TCCA, CASA) are allowing for quite a long time CAT SET-IMC.
- An environmental issue since the current regulatory status does not promote the use of modern aeroplanes with a better environment footprint especially regarding emissions of lead and CO.
- An economic issue since the current situation prevents the opening of new low density routes which could be operated safely and efficiently only by some single-engined turbine aeroplanes due to performance or operating cost considerations.
- A social issue since the current situation prevents the opening of new routes to remote areas and, therefore, reduces the possibility of movement of the population living in remote areas.

As detailed later in paragraph 4, the target fatal accident rate to be demonstrated while addressing the above issues is set to 4 per million flight hours, taking into account a powerplant reliability rate of 10 per millions flight hours as an eligibility criterion. This rate is intended to include all in-flight shut down and loss of power whatever the causes.

2.2. Objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. This proposal will contribute to the achievement of the overall objectives by addressing the issues outlined in Chapter 2 of this NPA.

The specific objective of this proposal is to allow single-engined turbine aeroplanes meeting specified powerplant reliability, equipment, operating and maintenance requirements to conduct commercial air transport operations at night and/or in IMC (except under special VFR).

2.3. Summary of the Regulatory Impact Assessment (RIA)

The following options were analysed within the RIA:

Table 1: Selected policy options

Option No	*Short title*	**Description**
0	No action	Baseline option (no change in rules; risks remain as outlined in the

		issue analysis).
1	NPA OPS 29 Rev 2	Draft rules for CAT SET-IMC operations based on JAA NPA OPS 29 Rev 2
2	NPA OPS 29 Rev 2 + QINETIQ	Draft rules for CAT SET-IMC operations based on JAA NPA OPS29 Rev 2 taking into consideration all QINETIQ recommendations
3	NPA OPS 29 Rev 2 + additional mitigations	Draft rules for CAT SET-IMC operations based on JAA NPA OPS29 Rev 2 taking into consideration some QINETIQ recommendations and some counter proposals from the rulemaking group.

Table 2 presents a summary of the impacts of the selected options. For more details, refer to Chapter 4.

Table 2: Summary of the impacts of the defined options.

	Option 0	**Option 1**	**Option 2**	**Option 3**
Safety impact	**-1**	**+1**	**+1.2**	**+1.5**
Environmental impact	**0**	**+1**	**+1**	**+1**
Social impact	**0**	**+3**	**+3**	**+3**
Economic/proportionality impact	**-1**	**+3**	**+1.4**	**+3.3**
Impact on 'better regulation' and harmonisation	**0**	**+1**	**-1.2**	**+0.8**
Total	**-2**	**+9**	**+5.4**	**+9.6**

Option 0 'Do nothing' has a negative assessment, which means that if no regulatory actions are taken, the current situation will develop into less safe operations and higher cost of operations. The options 1, 2, 3 provide the answers to these concerns. They are all assessed with a global positive outcome.

Option 1 and 3 impacts are considered to be very close since option 3 introduces only minor modifications to the NPA OPS 29 Rev 2 based on the counter proposal made by the group to address some of the concerns raised by the QINETIQ study.

Option 2 global impact is less positive than option 1 and 3 because it was found to introduce negative impacts in the aspects of economic, proportionality and 'better regulation'/harmonisation.

Option 3 is considered to be the most appropriate option as it will improve safety and efficiency. It provides at least equivalent benefits in all areas compared to option 1 (direct transposition of NPA OPS 29 Rev 2) with some minor safety improvement, but avoids the implementation issues foreseen for option 2. These safety improvements are linked to the following counter proposals:

- New guidance related to the use of a methodology for the assessment of the risk associated with CAT SET-IMC on specific routes;
- New guidance related to the assessment of the weather conditions on landing sites for which no weather information is published; and
- Recording of CAT SET-IMC experience by the competent authority.

Option 3 ensures also more efficient requirements from an economic perspective, by relying on the operator management system and especially on a procedure to assess each route to be operated, rather than requiring each route to be approved by the competent authority.

2.4. Overview of the proposed amendments

As a result of the RIA, this NPA proposes new operational rules amending Regulation (EU) No 965/2012 and associated AMC and GM related to CAT SET-IMC operations.

The proposed amendment are, therefore, mostly a transposition of the JAA NPA OPS 29 Rev 2 provisions together with some additional mitigations to address some issues highlighted by the QinetiQ's study.

- Since it is proposed that a specific approval is required to be allowed to operate CAT SET-IMC operations, the Appendix II to Part-ARO containing the template for the operations specifications has been updated to include this new CAT-SET-IMC specific approval.
- CAT.OP.MPA.136 is amended to take into account the possibility for an operator holding a CAT SET-IMC specific approval to make use of a risk period over certain areas.
- CAT.OP.MPA.180 is amended to require a take-off alternate aerodrome to be selected for CAT SET-IMC operations if it is not possible to use the departure aerodrome as a take-off alternate aerodrome due to meteorological or performance reasons.
- CAT POL.A.300 is amended to reflect the introduction of the CAT SET-IMC specific approval in Part-SPA.
- CAT.POL.A.320 is amended to take into account the possibility for an operator holding a CAT SET-IMC specific approval to make use of a risk period over certain areas.
- A new subpart L is inserted in Part-SPA for the CAT SET-IMC new specific approval.
- A new paragraph SPA.SET-IMC.100 is inserted to introduce the requirement to be granted with a specific approval to conduct CAT SET-IMC operations.
- A new paragraph SPA.SET-IMC.105 is added to provide a list of the additional requirements to be met to be allowed to conduct CAT SET-IMC operations. Compared to the NPA OPS 29 Rev 2, the reference to a specific amendment of the airworthiness standards used for aeroplane type certification has been removed (JAR 23 initial issue or FAR Part 23 amendment 28). It was not considered necessary to transpose these references since the aeroplane C208 Caravan, which was the first single-engined turboprop aeroplane type-certificated, was certified against these standards. Therefore, all the other SETs are considered to have been certified against a more recent certification standard.

- A new paragraph SPA.SET-IMC.110 is added to provide the additional equipment requirements for CAT SET-IMC operations.

  In addition, the wording of the requirement related to the ignition system has been aligned with the ICAO Annex 6 part I wording since it was considered to be clearer than the NPA OPS 29 Rev 2 wording.

  The particle detection system requirement has been reworded as well to highlight the need to have this system operative throughout the flight and to provide more flexibility to address future technology (i.e. ceramic bearings) and future systems.

- A new AMC3 ARO.OPS.200 is added to define what actions have to be conducted by the competent authority when verifying compliance with Subpart L of Part-SPA and issuing a CAT SET-IMC approval, including the validation of the operational capability of an operator.

- GM3 ORO.GEN.130(b) is amended to add CAT SET-IMC operations as an item requiring a prior approval from the competent authority.

- AMC1 ORO.GEN.160 is amended to clearly specify that any engine related diversion or turn-back during CAT SET-IMC operations has to be reported to the competent authority. It should be noted that Directive 2003/42/EC has been repealed by Regulation (EU) No 376/2014 published on 03 April 2014. The amendment of the ORO.GEN.160 implementing rule and associated AMC to take this into account will be addressed in the frame of RMT.0516/517 'Updating Part-ARO and Part-ORO' which is currently being processed by the Agency.

- AMC3 ORO.MLR.100 is amended to add in the OM content under paragraph A. 8.1.1.13 the planning procedure required to be defined to conduct CAT SET-IMC operations and under paragraph C.2 the information related to the available landing sites along the CAT SET-IMC routes operated.

- A new AMC1 SPA.SET-IMC.105(a) is added to provide criteria related to the acceptable level of propulsion system reliability for CAT SET-IMC operations. A maximum loss of power rate and a minimum level of in-service experience are defined with means to comply when the engine-aeroplane combination has insufficient in-service experience.

- A new AMC1 SPA.SET-IMC.105(b) is added to define specific maintenance requirements for CAT SET-IMC operations, including the engine monitoring programme and the propulsion and primary systems reliability programme.

- A new AMC1 to SPA.SET-IMC.105(c) is added to define CAT SET-IMC operations specific requirements in the area of crew training and checking.

- A new AMC1 SPA.SET-IMC.105(d)(2) is added to provide criteria for the definition by the operator of a planning procedure describing the methodology for the analysis of a new CAT SET-IMC route to be operated. This paragraph also introduces as a mean of compliance a total maximum duration of the risk periods used during a flight of 15 minutes.

- A new AMC2 SPA.SET-IMC.105(d)(2) is added to define the general criteria on which the assessment of the landing site to be selected along the CAT SET-IMC routes has to rely.

- A new AMC3 SPA.SET-IMC.105(d)(2) is added to provide additional criteria related to the selection of departure and arrival procedure and to the selection of the planned or diversion routes for CAT SET-IMC operations.

- A new GM1 SPA.SET-IMC.105(d)(2) is added to provide information on the definition of landing site in the context of CAT SET-IMC.
- A new GM2 SPA.SET-IMC.105(d)(2) is added to provide guidance on the use of a risk assessment methodology by the operator to evaluate the risk associated with CAT SET-IMC operation on a specific route.
- A new AMC1 SPA.SET-IMC.110(b) is added to state that a back-up or standby attitude indicator installed in glass cockpit installations is an acceptable means of compliance for the second attitude indicator.
- A new AMC1 SPA.SET-IMC.110(d) is added to provide an acceptable standard for the airborne weather detecting equipment.
- A new AMC1 SPA.SET-IMC.110(f) is added to provide acceptable standards for the area navigation system requirement.
- A new GM1 SPA.SET-IMC.110(h) is added to highlight the fact that the operator has to get information from the TCH or STCH as applicable regarding the conformity status of the landing light with the 200 ft illumination requirement contained in SPA.SET-IMC.110(h).
- A new GM1 SPA.SET-IMC.110(i)(7) is added to provide examples of elements that might affect pilot’s vision for landing.
- A new AMC1 SPA.SET-IMC.110(l) is added to provide further information on the means that permits continuing operation of the engine through a sufficient power range to safely complete the flight in the event of any reasonably probable failure of the fuel control unit, as required in the corresponding implementing rule.

As stated in the objectives of the task, the proposed text is intended to be at least aligned with the current ICAO provisions for CAT SE-IMC contained in the Annex 6. The JAA working group has assessed the JAA NPA OPS 29 Rev 2 in comparison to the ICAO Annex provisions and has established that it was at least meeting the ICAO SARPs. A similar exercise has been performed for the proposed amendments of this NPA and it was concluded that the proposed text is fully compliant with ICAO Annex 6 provisions for CAT SET-IMC. A cross-reference table, contained in Appendix I, between the proposed text and the ICAO Annex 6 has been established to support this assessment.

3. Proposed amendments

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey;

(c) an ellipsis (…) indicates that the remaining text is unchanged in front of or following the reflected amendment.

3.1. Draft Regulation (Draft EASA Opinion) — proposed changes to Regulation (EU) No 965/2012 — Cover Regulation

(1) Article 6 'Derogations'.

Paragraph 5 is deleted:

~~By way of derogation from CAT.POL.A.300(a) of Annex IV, single-engined aeroplanes, when used in CAT operations, shall be operated at night or in instrument meteorological conditions (IMC) under the conditions set out in the existing exemptions granted by Member States in accordance with Article 8(2) of Regulation (EEC) No 3922/91.~~

~~Any change to the operation of these aeroplanes that affects the conditions set out in those exemptions shall be notified to the Commission and the Agency before the change is implemented. The Commission and the Agency shall assess the proposed change in accordance with Article 14(5) of Regulation (EC) No 216/2008.~~

(2) In addition, the amending Regulation to Commission Regulation (EU) No 965/2012 should include the following entry into force requirement.

'This Regulation shall enter into force on the 20th day following that of its publication in the Official Journal of the European Union.

It shall apply from [1 year after entry into force]. '

3.2. Draft Regulation (Draft EASA Opinion) — proposed changes to Annex II to Regulation (EU) No 965/2012 — Part-ARO

Appendix II to Part-ARO

OPERATIONS SPECIFICATIONS **(subject to the approved conditions in the operations manual)**
Issuing Authority Contact Details Telephone[1]: ____________________; Fax: ____________________; E-mail: ____________________
AOC#[2]: Operator Name[3]: Dba Trading Name Date[4]: Signature: Operations Specifications#:
Aircraft Model[5]: Registration Marks[6]:

Commercial operations ☐……..				
Area of operation[7]:				
Special Limitations[8]:				
Specific Approvals:	Yes	No	Specification[9]	Remarks
Dangerous Goods	☐	☐		
Low Visibility Operations Take-off Approach and Landing Take-off	 ☐ ☐	 ☐ ☐	RVR[11]: m CAT[10].... RVR: m DH: ft	
RVSM[12] ☐ N/A	☐	☐		
ETOPS[13] ☐ N/A	☐	☐	Maximum Diversion Time[14]: min.	
Navigation specifications for PBN Operations[15]	☐	☐		[16]
Minimum navigation performance specification	☐	☐		
Single-engined turbine aeroplane operations at night or in IMC (SET-IMC)	☐	☐	[21]	
Helicopter operations with the aid of night vision imaging systems	☐	☐		
Helicopter hoist operations	☐	☐		
Helicopter emergency medical service operations	☐	☐		
Cabin crew training[17]	☐	☐		
Issue of CC attestation[18]	☐	☐		
Continuing airworthiness	☐	☐	[19]	
Others[20]				

[..]

21. Insertion of the particular airframe/engine combination.

[..]

3.3. Draft Regulation (Draft EASA Opinion) — proposed changes to Annex IV to Regulation (EU) No 965/2012 — Part-CAT

CAT.OP.MPA.136 Routes and areas of operation — single-engined aeroplanes

Unless approved by the competent authority in accordance with Annex V (Part-SPA), Subpart L (SET-IMC), ~~T~~the operator shall ensure that operations of single-engined aeroplanes are only conducted along routes, or within areas, where surfaces are available that permit a safe forced landing to be executed.

CAT.OP.MPA.180 Selection of aerodromes — aeroplanes

(a) Where it is not possible to use the departure aerodrome as a take-off alternate aerodrome due to meteorological or performance reasons, the operator shall select another adequate take-off alternate aerodrome that is no further from the departure aerodrome than:

[..]

(3) for operations approved in accordance with Annex V (Part-SPA), Subpart L (SET-IMC), 30 minutes flying time at normal cruising speed in still air conditions, based on the actual take-off mass.

[..]

CAT.POL.A.300 General

~~(a) The operator shall not operate a single-engined aeroplane:~~

~~(1) at night; or~~

~~(2) in IMC except under special VFR.~~

~~(b)~~ The operator shall treat two-engined aeroplanes that do not meet the climb requirements of CAT.POL.A.340 as single-engined aeroplanes.

CAT.POL.A.320 En-route — single-engined aeroplanes

Unless approved by the competent authority in accordance with Annex V (Part-SPA), Subpart L (SET-IMC):

(a) In the meteorological conditions expected for the flight, and in the event of engine failure, the aeroplane shall be capable of reaching a place at which a safe forced landing can be made.

(b) It shall be assumed that, at the point of engine failure:

(1) the aeroplane is not flying at an altitude exceeding that at which the rate of climb equals 300 ft per minute, with the engine operating within the maximum continuous power conditions specified; and

(2) the en-route gradient is the gross gradient of descent increased by a gradient of 0.5 %.

3.4. Draft Regulation (Draft EASA Opinion) — proposed changes to Annex V to Regulation (EU) No 965/2012 — Part-SPA

Subpart L — Single-engined turbine aeroplane operations at night or in IMC (SET-IMC)

SPA.SET-IMC.100 SET-IMC operations

In commercial air transport operations, single-engined turbine aeroplanes shall only be operated at night or in IMC if the operator has been granted a SET-IMC approval by the competent authority.

SPA.SET-IMC.105 SET-IMC operations approval

To obtain a SET-IMC operational approval by the competent authority, the operator shall provide evidence that:

(a) an acceptable level of turbine engine reliability can be or has been achieved in service by the world fleet for the particular airframe-engine combination;

(b) specific maintenance instructions and procedures to ensure the intended levels of continued airworthiness and reliability of the aeroplane and its propulsion system have been established and included in the operator's aircraft maintenance programme in accordance with Annex I to Regulation (EC) No 2042/2003 (Part-M) including:

(1) an engine monitoring programme;

Aeroplanes first issued with an individual certificate of airworthiness after 31 December 2004 should have an automatic trend monitoring system;

(2) a propulsion and primary systems reliability programme;

(c) flight crew composition and a training/checking programme for the flight crew members involved in these operations have been established; and

(d) operating procedures have been established specifying:

(1) the equipment to be carried, including its operating limitations and appropriate entries in the MEL;

(2) flight planning; and

(3) in-flight procedures, including procedures following a propulsion system failure and forced landing procedures in all weather conditions.

SPA.SET-IMC.110 Additional equipment requirements for SET-IMC operation

Aeroplanes used for SET-IMC operations shall be equipped with:

(a) two separate electrical generating systems, each one capable of supplying adequate power for all essential flight instruments, navigation systems and aeroplane systems required for continued flight to the destination or alternate aerodrome;

(b) Two attitude indicators, powered from independent sources;

(c) for passenger operations, a shoulder harness or a safety belt with a diagonal shoulder strap for each passenger seat;

(d) an airborne weather detecting equipment;

(e) in a pressurised aeroplane, sufficient additional oxygen for all occupants to allow descent following engine failure from the maximum certificated cruising altitude, to be made at the best range gliding speed and in the best gliding configuration, assuming the maximum cabin leak rate, until sustained cabin altitudes below 13 000 ft are reached;

(f) an area navigation system using equipment qualified for approach accuracies and capable of being programmed with the positions of landing sites. Pre-programmed positions shall not be altered in flight;

(g) a radio altimeter;

(h) a landing light, capable of illuminating the touchdown point from 200 ft on the power-off glide path;

(i) an emergency electrical supply system (battery) of sufficient capacity and endurance capable of providing power following the failure of all generated power, for additional loads necessary for:

(1) essential flight instruments and area navigation during descent from maximum operating altitude after engine failure;

(2) the means to provide for one attempt at engine restart;

(3) if appropriate, the extension of landing gear and flaps;

(4) use of the radio altimeter throughout the landing approach;

(5) the landing light;

(6) one pitot heater; and

(7) if appropriate, means to give sufficient protection from the elements against impairment of the pilot's vision for landing.

(j) an ignition system that activates automatically, or is capable of being operated manually, for take-off and landing, and during flight, in visible moisture;

(k) a means of continuously monitoring the powertrain lubrication system for the presence of debris associated with the imminent failure of a drivetrain component, including a flight deck caution indication; and

(l) an emergency engine power control device that permits continuing operation of the engine through a sufficient power range to safely complete the flight in the event of any reasonably probable failure of the fuel control unit.

3.5. Draft EASA Decision proposed changes to ED Decision 2012/016/R — Part-ARO

Proposed changes to Decision 2012/016/R of the Executive Director of the Agency of 25 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 5 October 2012 — Acceptable Means of Compliance and Guidance Material to Annex II (Part-ARO)

AMC3 ARO.OPS.200 Specific approval procedure

PROCEDURES FOR THE APPROVAL OF COMMERCIAL AIR TRANSPORT OPERATIONS WITH SINGLE-ENGINED TURBINE AEROPLANES IN IMC OR AT NIGHT (CAT SET-IMC)

(a) When verifying compliance with the applicable requirements of Subpart L of Annex V (SET-IMC), the competent authority should check the operator’s capability to safely carry out the intended operations in all proposed areas.

In addition, the competent authority should assess the operator’s safety performance, flight crew training and operators ‘experience, as reflected in the data provided by the operator with its application, to ensure that the intended safety level is achieved.

In the case of new operators without a significant experience, the competent authority should at least assess the processes put in place by the operator to manage the safety of its operations.

(b) The competent authority may apply temporary restrictions (e.g. specific routes) until such time as the competent authority is satisfied with the above.

(c) When issuing the approval, the competent authority should specify:

(1) the particular airframe/engine combination;

(2) the identification of those individual aeroplanes designated for single-engine night and/or IMC operation by make, model and registration; and

(3) the authorised areas and/or routes of operation.

VALIDATION OF OPERATIONAL CAPABILITY

Observation by the competent authority of a validation flight, simulating the proposed operation in the aeroplane should be carried out before an approval is granted. This should include flight planning and pre-flight procedures. It should also include a demonstration of the following simulated emergency procedures, in adverse conditions including:

(a) total failure of the propulsion system;

(b) total loss of normal generated electrical power

3.6. Draft EASA Decision proposed changes to ED Decision 2012/017/R (Part-ORO)

Proposed changes to Decision 2012/017/R of the Executive Director of the Agency of 24 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 5 October 2012 — Acceptable Means of Compliance and Guidance Material to Annex III (Part-ORO).

GM3 ORO.GEN.130(b) Changes

CHANGES REQUIRING PRIOR APPROVAL

[..]

(s) Commercial air transport operations with single-engined turbine aeroplane in IMC or at night (CAT SET-IMC)

AMC1 ORO.GEN.160 Occurrence reporting

GENERAL

[..]

(c) In addition to the report required by Regulation (EU) No 376/2014, the operator approved in accordance with Annex V (Part-SPA), Subpart L (SET-IMC), should report any engine related diversion or turn-back during the related operations and all failures or events which could lead to loss of power.

AMC3 ORO.MLR.100 Operations manual — general

CONTENTS — COMMERCIAL AIR TRANSPORT OPERATIONS

[..]

A GENERAL/BASIC

[..]

8 OPERATING PROCEDURES

[..]

8.1.13 For SET-IMC operations approved in accordance with Annex V (Part-SPA), Subpart L (SET-IMC), the procedure for route selection with respect to the availability of surfaces that permits a safe forced landing including instructions for the assessment of landing sites (elevation, landing direction and obstacles in the area) and for the assessment of the weather conditions at these landing sites.

C ROUTE/ROLE/AREA AND AERODROME/OPERATING SITE INSTRUCTIONS AND INFORMATION

[..]

2 Information related to landing sites available for operations approved in accordance with Annex V (Part-SPA), Subpart L (SET-IMC), including:

(a) description of the landing site (position, surface, slope, elevation,…);

(b) preferred landing direction; and

(c) obstacles in the area.

[..]

3.7. Draft EASA Decision proposed changes to ED Decision 2012/019/R (Part-SPA)

Proposed changes to Decision 2012/019/R of the Executive Director of the Agency of 24 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 5 October 2012 — Acceptable Means of Compliance and Guidance Material to Annex V (Part-SPA).

AMC1 SPA.SET-IMC.105 SET-IMC operations

ANNUAL REPORT

After obtaining the initial approval, the operator should make available to its competent authority on an annual basis a report related to its CAT SET-IMC operations containing at least the following information:

(a) Number of CAT SE-IMC flights operated;

(b) Number of CAT SET-IMC hours flown; and

(c) Number of occurrences sorted by type;

AMC1 SPA.SET-IMC.105(a) SET-IMC operations

TURBINE ENGINE RELIABILITY

(a) The operator should obtain the powerplant reliability data from the type certificate holder (TCH) and/or supplemental type certificate (STC) holder.

(b) The data considered relevant and reliable for the engine-airframe combination should have demonstrated, or be likely to demonstrate, a rate of turbine engine in-flight shutdown, or loss of power for all causes such that a forced landing is inevitable, of less than 10 per million flight hours.

(c) The in-service experience of the intended airframe/engine combination should be at least 20 000 hours, demonstrating the required level of reliability. If this experience has not been accumulated, but if experience exists for a similar or related type of airframe and turbine engine, then an equivalent safety argument may be developed by the type certificate holder/STC holder in order to demonstrate that the reliability criteria are achievable. Additional testing or other relevant data may be considered as a compensating factor in the case of insufficient service experience.

AMC1 SPA.SET-IMC.105(b) SET-IMC operations

MAINTENANCE PROGRAMME

The following maintenance aspects should be addressed by the operator:

(a) Engine monitoring programme:

The operator's maintenance programme should include an oil consumption monitoring programme. This should be based on engine manufacturer's recommendations, if available. The programme should contain provisions to monitor trends with reference to the running average consumption; i.e. the monitoring must be continuous and take account of oil added. An engine oil analysis programme may also be required if recommended by the engine manufacturer. The opportunity to perform frequent (recorded) power checks on a calendar basis should be considered.

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

(b) Propulsion and primary systems reliability programme:

A propulsion and primary systems reliability programme should be established or the existing reliability programme supplemented for the particular engine/airframe combination. This programme should be designed to achieve early identification and prevention of problems, which would affect the ability of the aeroplane to perform safely its intended flight.

Where the single-engined night and/or IMC fleet is part of a larger fleet of the same airframe-engine combination, data from the operator's total fleet will be acceptable. Where statistical assessment alone may not be applicable, e.g. when the fleet size is small, the operator's performance will be reviewed on a case-by-case basis.

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, type certificate holders (TCHs) and the competent authority to help establish that the reliability level set out in AMC1 SPA.SET-IMC.105(a) is achieved. Any adverse sustained trend would require an immediate evaluation to be accomplished by the operator in consultation with its competent authority. The evaluation may result in corrective action or operational restrictions being applied.

The engine programme should include, as a minimum, engine hours flown in the period and the power loss rate for all causes and engine removal rate, both rates on a 12 month moving average basis.

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 which 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.

AMC1 SPA.SET-IMC.105(c) SET-IMC operations

TRAINING PROGRAMME

The operator's flight crew training and checking, established in accordance with ORO.FC, should incorporate the following elements:

(a) Conversion training

Conversion training should be conducted in accordance with a syllabus devised for the operation of single-engined aeroplanes at night and/or in IMC and include at least the following:

(1) Normal Procedures

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

(ii) Navigation systems procedures;

(iii) Radar positioning and vectoring when available;

(iv) Use of radio altimeter;

(v) Use of fuel control, displays interpretation.

(2) Abnormal Procedures

(i) Anti- and de-icing system failures;

(ii) Navigation system failure;

(iii) Pressurisation system failures;

(iv) Electrical System failures;

(v) Engine-out descent in simulated IMC.

(3) Emergency Procedures

(i) Engine failure shortly after take-off;

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

(iii) Engine failure other than above:

- Recognition of failure; symptoms, type of failure, actions to be taken and consequences

(iv) Depressurisation;

(v) Engine re-start procedures;

- Choice of aerodrome or landing site
- Use of area navigation system

(vi) ATC communications;

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

(viii) Use of radio altimeter;

(ix) Practice forced landing procedure to touchdown in simulated IMC, with zero thrust set, and operating on simulated emergency electrical power;

(b) Use of simulator (conversion training);

(1) A full flight simulator (FFS) may be used to carry out training in the items required in (a) above for single-engine night and/or IMC conversion training;

(2) A flight training device (FTD) may be used to carry out training in normal procedures specified in (a)(1) above.

(c) Conversion checking

The following items should be checked following completion of single-engine night and/or IMC conversion training as part of the operator proficiency check (OPC):

(1) Conduct forced landing procedure in simulated IMC to touchdown, with zero thrust set, and operating on simulated emergency electrical power;

(2) Engine re-start procedures;

(3) Depressurisation following engine failure;

(4) Engine-out descent in simulated IMC.

(d) Use of simulator (conversion checking)

A full flight simulator (FFS) may be used to carry out checking of the items required in (c) above for single-engine night and/or IMC conversion checking.

(e) Recurrent training

Recurrent training for single-engine night and/or IMC should be included in the recurrent training required by ORO.FC for pilots carrying out single-engine night and/or IMC operations. This training should include all the items in (a).

(f) Use of Simulator (recurrent training)

Following conversion training and checking, the next recurrent training session may be conducted in either the aeroplane, or a full flight simulator. Thereafter, recurrent training may be carried out either on the aeroplane or in a full flight simulator.

(g) Recurrent checking

The following items should be included in the list of required items to be checked following completion of single-engine night and/or IMC recurrent training as part of the operator proficiency check (OPC):

(1) Conduct forced landing procedure to touchdown in simulated IMC, with zero thrust set, and operating on simulated emergency electrical power;

(2) Engine re-start procedures;

(3) Depressurisation following engine failure;

(4) Emergency descent in simulated IMC;

(h) Use of Simulator (recurrent checking).

Following conversion training and checking, the next operator proficiency check (OPC) including single-engine night and/or IMC items may be conducted in either the aeroplane, or a full flight simulator. Thereafter, single-engine night and/or IMC OPCs may be carried out either on the aeroplane or in a full flight simulator.

AMC1 SPA.SET-IMC.105(d)(2) SET-IMC operations

FLIGHT PLANNING

(a) The operator should establish flight planning procedures to ensure that the routings and cruise altitude are selected so as to have a landing site within gliding range.

(b) Notwithstanding (a), one or more risk periods of no more than a total of 15 minutes per flight may be determined whenever a landing site is not within gliding range and for the following operations:

(1) over water;

(2) over terrain which prevents a safe forced landing to be accomplished because the surface is inadequate;

(3) over congested areas; or

(4) over areas where occupants cannot be adequately protected from the elements, or where search and rescue response/capability is not provided consistent with anticipated exposure;

If a risk period is used, then carriage of appropriate survival equipment should be specified by the operator.

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

(1) the selection of aerodromes along the route;

(2) the identification and the assessment of the acceptability of landing sites (obstacles,etc.) along the route when no aerodrome is available;

(3) assessment of en-route specific weather conditions that could affect the capability of the aeroplane to reach the selected forced landing area following a loss of power (i.e severe icing conditions, headwinds,etc.);

(4) consideration of en-route weather information relevant to landing sites to the extent that such information is available from local or other sources. Expected weather conditions for landing sites for which no weather information is available, should be assessed and evaluated taking into account a combination of the following information:

(i) local observations;

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

(iii) TAF/METAR of the nearest aerodromes.

(5) protection of the aeroplanes occupants after landing in case of adverse weather.

AMC2 SPA.SET-IMC.105(d)(2) SET-IMC operations

LANDING SITE

(a) 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 surface. For such landing sites, the assessment should include confirmation of updated terrain characteristics and presence of obstacles.

(b) Landing sites suitable for a diversion or forced landing should be programmed into the area navigation system so that track and distance are immediately and continuously available.

AMC3 SPA.SET-IMC.105(d)(2) SET-IMC operations

ROUTE AND INSTRUMENT PROCEDURE SELECTION

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

(a) The operator should ensure that the instrument departures procedures to be followed are those where the flight path would ensure that, in the event of a loss of power, the aeroplane could land on a landing site.

(b) Arrival

The operator should ensure that the only arrival procedures to be followed are those where the flight path would ensure that, in the event of a loss of power, the aeroplane could 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 a loss of power, the pilot would be able to make a safe landing at a landing site.

GM1 SPA.SET-IMC.105(d)(2) SET-IMC operations

LANDING SITE

A landing site is an aerodrome or an area where a safe forced landing can be performed by day or night.

GM2 SPA.SET-IMC.105(d)(2) SET-IMC operations

SAFETY RISK ASSESSMENT

The operator may decide to further assess some specific routes and therefore to conduct a specific risk assessment to evaluate the associated risk and determine if additional mitigation could be needed. For this purpose, a methodology taking into account the airfield aspects, as well as those of the aeroplane itself and based on the following principles, may be used by the operator:

(a) The methodology used should aim at estimating the likelihood of failing to achieve a successful landing in case of an engine failure, a successful landing being defined as one with no damage or injuries sustained;

(b) It should consist of generating a risk profile for a specific route, including departure, en-route and arrival airfield and runway, splitting the proposed flight into appropriate segments, and estimating the risk for each segment should the engine fail 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 failure, the position relative to the departure or destination airfield or to an emergency landing site 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 failure can be calculated and converted to a 'per flight hour' basis.

AMC1 SPA.SET-IMC.110(b) Additional equipment requirements for CAT SET-IMC operation

ATTITUDE INDICATOR

A back-up or standby attitude indicator installed in glass cockpit installations is an acceptable means of compliance for the second attitude indicator.

AMC1 SPA.SET-IMC.110(d) Additional equipment requirements for CAT SET-IMC operation

AIRBORNE WEATHER DETECTING EQUIPMENT

The airborne weather detecting equipment should be an airborne weather radar as defined in the applicable CS-ETSO issued by the Agency or equivalent.

AMC1 SPA.SET-IMC.110(f) Additional equipment requirements for CAT SET-IMC operation

AREA NAVIGATION SYSTEM

An acceptable standard for the area navigation system is the European technical standards order ETSO-145/146c, ETSO-C129a, ETSO-C196a or ETSO-C115 issued by the Agency or equivalent.

GM1 SPA.SET-IMC.110(h) Additional equipment requirements for CAT SET-IMC operation

LANDING LIGHT

In the absence of relevant data available in the AFM, the operator should liaise with the type certificate (TC) holder or the supplemental type certificate (STC) holder as applicable, to obtain a statement of conformity.

GM1 SPA.SET-IMC.110(i)(7) Additional equipment requirements for CAT SET-IMC operation

ELEMENTS AFFECTING PILOT'S VISION FOR LANDING

Examples of elements affecting pilot's vision for landing are rain and window fogging.

AMC1 SPA.SET-IMC.110(l) Additional equipment requirements for CAT SET-IMC operation

EMERGENCY ENGINE POWER CONTROL DEVICE

The means that permits continuing operation of the engine through a sufficient power range to safely complete the flight in the event of any reasonably probable failure of the fuel control unit should enable the fuel flow modulation in the event of any likely control malfunction.

4. Regulatory Impact Assessment (RIA)

4.1. Issues to be addressed

4.1.1. General issues

Current regulatory issues

Under the current applicable regulation for commercial air transport, i.e. Regulation (EU) No 965/2012, commercial air transport with single-engined aeroplanes operated at night or in instrument meteorological conditions except under special VFR (CAT SET-IMC) is not permitted mainly because of the risk involved with the level of powerplant reliability that existed when the ICAO rules were originally promulgated. (see paragraph 4.1.2 for a detailed safety analysis).

Nevertheless, some EU Member States, including Finland, France, Greece, Norway, Spain and Sweden, have already approved, under exemptions to EU-OPS, domestic CAT SET-IMC operations under specific conditions. Currently 4 of these countries (F, NO, FI and SW) have still operators carrying CAT SET-IMC operations under an exemption.

It should be noted that Regulation (EU) No 965/2012 foresees in Article 6(5) that these exemptions granted in accordance with Article 8(2) of Regulation (EC) No 3922/91 remain valid and that any change to the conditions associated with the exemptions shall be notified to the European Commission and the Agency which will assess these changes in accordance with Article 14(5) of Regulation (EC) No 216/2008.

Therefore, there is an harmonisation and a level-playing field issue within Europe since these operations are only approved in some EU Member States. In addition, it should be noted that these exemptions are based on different set of conditions, which even prevents a level playing field among the operators allowed to operate CAT SET-IMC. The fact that new exemptions might be submitted has to be highlighted as well. The Agency and the members of the rulemaking group are aware of several new projects for such operations in Europe. In addition to that, some EU operators are facing competition from TCO operators coming from countries where CAT SET-IMC is not forbidden.

As stated in paragraph 8 of Regulation (EC) No 3922/91, Member States willing to allow one of their operator to operate CAT SET-IMC flights, are required to notify the European Commission of the exemption. Member States have to demonstrate that the conditions associated with the exemption allow an equivalent level of safety to the one provided by the applicable rule. This creates administrative burden which could be avoided if the rules were harmonised in Europe.

ICAO compliance issue:

ICAO published amendment 29 to ICAO Annex 6, applicable since 2005, which allows single-engined turbine-powered aeroplane commercial operations at night and/or in IMC under specific conditions which are defined in an appendix to the standards and recommended practices (SARPs).

The ICAO SARPs related to CAT SET-IMC operations have not been transposed yet leaving the European regulatory framework not aligned with ICAO standards and also not harmonised with the other major third countries which are currently allowing CAT SET-IMC such as USA, Canada and Australia.

Environmental issue:

The current regulatory status does not promote the use of modern aeroplanes with a better environment footprint especially regarding emissions of lead and CO.

Social issue:

From a social perspective, the current situation prevents the opening of new low density routes which could be operated safely and efficiently only by some single-engined turbine aeroplanes due to performance or operating cost considerations. This prevents the improvement of movement possibilities of the population living in remote areas.

Economic issue

Some manufacturers, including some European ones, have developed reliable aeroplanes which are designed to be operated in CAT SET-IMC and which are currently operated in CAT SET-IMC in other parts of the world. Nevertheless, due to the current regulation, these aeroplanes can be operated in IMC only in non-commercial operations in Europe.

The European single-engined turboprop aeroplane fleet conducting commercial air transport (CAT) operations has declined during the past decade. In 2006, there were approximately 30 single-engined turboprop aeroplanes involved in CAT operations in Europe. In 2013, however, there are only 13 known aeroplanes in CAT operations in Europe (see table 3 in paragraph 4.1.3.2).

The current situation prevents the development of new business based on the opening of new routes to serve remote communities. These new routes would enhance the economic viability of these communities and will provide as well opportunities for airfreight and tourist operations in all areas.

4.1.2. Safety risk assessment

Under the current applicable regulation for commercial air transport, i.e. Regulation (EU) No 965/2012, commercial air transport with single-engined turbine aeroplanes operated at night or in instrument meteorological conditions, except under special VFR (CAT SET-IMC), is not permitted mainly because of the risk involved with the level of powerplant reliability that existed when the ICAO rules were originally promulgated. This section will analyse the validity of such statement in the light of new elements.

4.1.2.1 Powerplant rate

The reliability rate of turboprop engines currently used on eligible single turboprop aeroplanes for CAT SET-IMC operations, is considered to be below 10 per millions flight hours (See appendix K), which was the QINETIQ and the JAA NPA OPS 29 Rev 2 powerplant reliability target.

This rate has been considered as a basis for this risk assessment exercise and this NPA.

4.1.2.2 CAT SET-IMC operations fatal accident rate.

First, it is useful to consider the latest NTSB statistics which are showing over the last 10 years an average fatal accident rate for Part 135 operations (commuter and on-demand operations) of 5.51/million flight hours.

The data coming from the Breiling study (Breiling 2012 Annual Single Turboprop Powered Aircraft Accident Review) was then considered to make the comparison between single-engine turboprop and twin turboprop aeroplanes operations. The scope of this study is the operations of light twin turboprop aeroplanes and single-engined turboprop aeroplanes in the USA and Canada from the introduction of the aeroplanes until 2010 and includes all commercial and non-commercial operations. In order to have a more representative sample, only the period 2005-2010 was considered and it showed a fatal accident rate of 3.96/million flight hours for light twin turboprop aeroplanes and 5.61/million flight hours for single-engined turboprop aeroplanes. In addition to that, if within the single turboprop aeroplanes, we consider only the 3 main types that are expected to be able to currently meet the NPA OPS 29 Rev 2 requirements, Cessna C208, Pilatus PC-12 and Socata TBM700/850, the resulting fatal accident rate is 4.44/million flight hours.

Since these figures are based on the same sample and area of operations, it can be concluded that the current safety rates of twin turboprop aeroplanes and single turboprop aeroplanes are in the same range and close to the value of 4/million flight hours, which was the QINETIQ recommended target fatal accident rate.

This target fatal accident rate of no more than 4 per million flight hours has been selected as a basis for the drafting of this NPA.

4.1.2.3 EU CAT SET-IMC Safety rate

Since CAT SET-IMC is not currently available within Europe, except on an exemption basis for some Members States and only for a few operators, it is not possible to derive a safety rate for the current CAT SET-IMC operations within Europe.

In addition, for the currently authorised operators, safety barriers in place are dependent on each Member State and are either based on ICAO Annex 6 provisions for CAT SET-IMC or on the JAA NPA OPS 29 Rev 2.

It should be noted that outside Europe the mitigation measures are various, from an uncontrolled environment in the USA, to a framework similar to the requirements of JAA NPA OPS 29 Rev 2 for example in Canada and Australia. the TCCA and CASA requirements for CAT SET-IMC are based on eligibility criteria to determine whether an aeroplane type can be operated in CAT SET-IMC and are considering turbine engine aeroplanes only. In addition, these regulations contain similar requirements in the area of crew training, equipment and operational procedures compared to the JAA NPA OPS 29 Rev 2.

In order to assess the risk of such operations, the rulemaking group has performed a risk assessment of CAT SET-IMC operations. To achieve this, the group has identified 8 main scenarios and for each of them has evaluated the consequences in terms of probability and severity, first without any specific mitigation and, secondly, considering the NPA OPS 29 Rev 2 mitigations. It was not considered necessary to assess all the possible scenarios since, in any case, the probability of occurrence would be expected to be lower than the one for 8 scenarios assessed.

It should be noted that the main aim of this risk assessment is to evaluate if the sum of the residual risk for each scenario is less than the selected target fatal accident rate (See 4.1.2.2) and, therefore, if the mitigations defined in the JAA NPA OPS 29 rev 2 could be sufficient to meet this target.

This risk assessment is as well based on the selected powerplant reliability rate of 10 per million flight hours (See 4.1.2.1).

The JAA NPA OPS 29 Rev 2 regulatory impact assessment and the QINETIQ risk assessment have been used to perform this risk assessment and especially for the evaluation of the probability of the consequences of an unsafe event.

It should be noted that in addition to the QINETIQ and JAA NPA OPS 29 Rev 2 data, this risk assessment is relying on some other public data or figures estimated by the rulemaking group when no data was available.

The conclusion of this risk assessment is that the mitigation contained in the NPA OPS 29 Rev 2 are found sufficient to at least allow reaching the required target fatal accident rate for CAT SET-IMC (see 4.1.2.2) and that no further mitigation is specifically required to reach this target.

The detailed risk assessment and information on the methodology used is provided in Appendix A.

4.1.3. Who is affected?

Operators, NAAs and manufacturers are considered to be affected by this task.

Operators are, so far, except on an exemption basis, not allowed to operate CAT SET-IMC flights which, therefore, limits the potential development of a new routes and new operations. In addition to that, the operators currently allowed to operate CAT SET-IMC flights are only allowed to fly on their national territory except when there is an agreement between Member States.

Under the current regulatory framework, Member States are required to inform the European Commission of an exemption if they want to allow one of their operator to operate CAT SET-IMC flights over their territory. Such Member States have to demonstrate that the conditions associated with the exemption allow an equivalent level of safety to the one provided by the applicable rule.

Manufacturers have developed reliable aeroplanes which are designed to be operated in CAT SET-IMC and which are currently operated in CAT SET-IMC in other parts of the world. Nevertheless, due to the current regulation, these aeroplanes can only be operated in IMC for non-commercial activities in Europe.

The current non-harmonised situation raises concerns as well since it is hardly understood by operators and manufacturers why such operations are allowed only in some areas of Europe under the exemption process.

Considering the JAA process during which it was not possible to have the draft NPA OPS 29 Rev 2 adopted due to the opposition to the concept from some Members States, the issue of CAT SE-IMC is definitely considered controversial.

4.1.3.1 Global turboprop aeroplanes fleet

The products affected by the current issue are the single-engined turbine aeroplanes. There are currently 3 main aeroplane types which are considered able to meet the NPA OPS 29 Rev 2 requirements: TBM700 (which includes TBM850), PC12 and C208.

It should be noted that the three types mentioned above (TBM700, PC12 and C208) represent 78 % of the single-engined turboprop aeroplanes currently operated in Europe, and 74 % in the US.

Regarding figures concerning the actual fleet operated, the General Aviation Manufacturers Association (GAMA) undertook an analysis of the single-engined and multi-engined turboprop fleet for Europe and the United States. GAMA reviewed each country’s aircraft registry using AvData’s (a JetNet Company) 2013 Jet and PropJet Business Aircraft Directory. The analysis was conducted based on the common make/model aeroplanes and focused only on civil registry aircraft and those models used in business transportation. Some common models, such as the DHC-2 Beaver which is often converted to a turboprop, were not included.

The analysis identified 368 single-engined turboprop aeroplanes and 557 multi-engine turboprop aeroplanes in Europe.

Comparably, the United States has a single-engined turboprop fleet which consists of 2 647 aeroplanes and a fleet of multi-engine turboprop aeroplanes registered in the United States of 4 695.

A close ratio of single-engined turboprop aeroplanes versus multi-engine turboprop is observed in Europe and in the US. It should be noted, nevertheless, that currently the FAA rules for commercial air transport operations with single-engined aeroplanes are not limited to single-engined turbine aeroplane and include as well single-engined piston aeroplanes.

It can be, therefore, concluded that a potential for a possible development of the fleet of single-engined aeroplanes exists in Europe if rules allowing CAT SE-IMC are published.

4.1.3.2 CAT SET-IMC fleet and operators trends

The European single-engined turboprop fleet that is conducting commercial air transport (CAT) operations has declined during the past decade. In 2006, there were approximately 30 SET aeroplanes involved in CAT operation in Europe. In 2013, however, there are only 12 known aeroplanes in CAT operations in Europe. The following table 3 shows the number of aeroplanes by country and operator.

Table 3: Number of SET aeroplanes operated in CAT in Europe, by Member State and by operator.

	2005/2006		**2013**	
	No	Operator	No	Operator
France	2 1 3 1	Finistair Atlantic Airlift (AAL) Air Caraibes Aviation Sans Frontières	1 1 2 3 1	Finistair CAIRE Aviation Sans Frontières Saint-Barth Commuter VolDirect
Finland	0	X	1	Hendell Aviation
Germany	2	OLT	0	X
Greece	4	Aeroland	0	X
Norway	7 2	BenAir Kato Air	3	BenAir
Spain	7	AirPack Express	0	X
Sweden	3	Nordflyg	1	Nordflyg
TOTAL ESTIMATED FLEET	**32**		**13**	

Source: Single Engine Turbine Alliance

SET aircraft that have stopped operations have not been replaced by alternative aircraft – Atlantic Airlift, Kato Air, OLT, Aeroland, Airpack Express have all gone out of business whereas Air Caraïbes has stopped SET operations.

According to the United States Federal Aviation Administration (FAA) there are currently 292 operators that conduct operations under 14 CFR Part 135 using single-engined aircraft. An additional three operators conduct operations under Part 121/135 for a total of 295 commercial operators using single-engined aircraft. (Source: FAA AFS-900.)

The U.S. fleet of single-engined turbine aeroplanes that is used in commercial operations has grown over the past decade. In 2006, there were 542 aeroplanes used by operators regulated under Part 135, but in 2013 that fleet has grown by 24 percent to 673 aeroplanes. The primary type is the Cessna CE-208 airplane. The following table shows how the U.S. Part 135 single-engined turboprop fleet has changed from 2006 to 2013 by type.

Table 4: Number of SET aeroplanes in the US under Part-135

	2006	**2013**
CE-208	472	488
Kodiak-100-100	0	6
PA-46-500TP	2	8
PC-12-45	64	99
PC-12-47/E	0	68
TBM-700-	4	4
TOTAL SET Aeroplanes	**542**	**673**

Source: U.S. FAA Part 135 Air Carrier Operations Branch Database (Analysed by GAMA)

Despite the fact that under FAA rules commercial air transport operations with single-engined aeroplanes are not limited to single-engined turbine aeroplane and include as well single-engined piston aeroplanes

4.1.4. How could the issue/problem evolve?

The actual situation is already partly non harmonised since some Member States are currently allowing such operations under exemptions while others are forbidding them. In addition, among the MS which currently allows such operations, the conditions on which the exemptions are based are not the same.

Since Regulation (EU) No 965/2012 foresees that existing exemptions remain valid, this non-harmonised situation is expected to continue and even increase since other Member States may apply for exemptions based on article 14.6 to Regulation (EC) No 216/2008 once Regulation (EU) No 965/2012 is implemented after October 2014. These exemptions could in addition be even based on other conditions compared to the ones on which the current exemptions are based. It is as well considered that the processing of these additional exemptions would represent additional administrative work for competent authorities.

Some parts of the EU population in remote areas would still not benefit from CAT operations with SET aeroplanes if such operations continue to be not allowed.

The current multi-engine turboprop and multi-engine piston fleet will continue to be operated without the efficient alternative the single-engined turbine aeroplanes could represent with a much better environmental impact than the single-engined turbine aeroplanes.

The operations of such aeroplanes in CAT may remain constant or even decline as shown in the table 3.

4.2. Objectives

As stated in paragraph 2.2, the specific objective of this proposal is to allow single-engined turbine aeroplanes meeting specified powerplant reliability, equipment, operating and maintenance requirements to operate commercial air transport flights at night and/or in IMC.

These rules are expected to address the issues described in paragraph 2.1.

4.3. Policy options

The following options have been identified by the rulemaking group to address the issues described in paragraph 1.1.

Table 5: Selected policy options

Option No	***Short title***	**Description**
0	No action	Baseline option (no change in rules; risks remain as outlined in the issue analysis).
1	NPA OPS 29 Rev 2	Draft rules for CAT SET-IMC operations based on JAA NPA OPS 29 Rev 2
2	NPA OPS 29 Rev 2 + QINETIQ	Draft rules for CAT SET-IMC operations based on JAA NPA OPS29 Rev 2 taking into consideration all QINETIQ recommendations
3	NPA OPS 29 Rev 2 + additional mitigations	Draft rules for CAT SET-IMC operations based on JAA NPA OPS29 Rev 2 taking into consideration some QINETIQ recommendations and some counter proposals from the rulemaking group.

The option of 'doing nothing'(option 0) is considered as the reference scenario.

4.3.1. Option 1 description

Option 1 is based on the transposition of the JAA NPA OPS 29 Rev 2 within the current European regulatory framework, without any additional requirement.

Nevertheless, some requirements contained in the JAA OPS NPA 29 Rev 2 has been either amended or not transposed for the following reasons:

4.3.1.1. Take-off minima:

The JAA NPA OPS 29 Rev was introducing specific take-off minima for CAT SET-IMC in appendix 1 to JAR-OPS 1.430. It basically required a minimum RVR of 800 m for approved CAT SET-IMC operations with, nevertheless, the possibility to use lower RVR when approved by the competent authority on a runway-by-runway basis. It was mentioned that such lower RVR values could be approved provided that the surface is likely to allow for a safe forced landing.

In addition to that it was clearly mentioned that the concept of the risk period could be used during the phase of flight and that therefore the safe forced landing was not to be considered in this case.

The rulemaking group considered that this would create an inconsistency since in any case an operator could make use of the risk period each time the actual RVR is below 800 m.

Therefore it was agreed that there was no need to introduce an additional approval and moreover to introduce more stringent requirements since in any case it can be easily circumvented by operators. The burden to check the availability of a safe forced landing area for each aerodrome and to possibly get an approval from the competent authority to be allowed to use an RVR lower than 800 m, is considered disproportionate and not appropriate.

Therefore it was agreed to remove any additional requirement related to the take-off minima and to make the take-off minima of the CAT.OP section applicable to CAT SE-IMC operations.

It should be noted in addition that as part of its management system, the operator has to perform a hazard identification and risk assessment of its operations and therefore it is considered that it should allow the operator to identify any needed mitigation to ensure an acceptable level of safety of these operations.

4.3.1.2 Approvals:

JAA NPA OPS 29 rev 2 was proposing to introduce a requirement for an approval to be allowed to conduct such operations. On top of that several additional approvals were foreseen such as the approval of the routes to be operated or the approval to use a take-off RVR below 800 m.

First of all it was considered on a general basis not necessary to introduce several approvals since a global approval could encompass all the possible individual other approvals and therefore reduce the administrative burden on operators and competent authorities.

This approach is considered as well to be more appropriate since it gives more credits to the operators which are required to implement a management system, including a compliance monitoring process and a risk management process.

Regarding this global approval, an assessment was then made to determine whether a specific approval should be required or if this could be covered by the issuance of an AOC.

The following criteria were considered to determine the need for a specific approval:

1. the aircraft, including its instruments, equipment and navigation avionics, has an airworthiness approval covering the type of envisaged IFR operations;
2. the complexity of said IFR operations does not present particular challenges for pilots and operators;
3. the concept and systems upon which the IFR operation will be carried out are mature enough (= not 'new'; standards and requirements validated and proved by experience);

4. the risk associated with normal, abnormal and emergency operations (including to third parties in the air or on the ground) is tolerable;
5. accuracy and integrity of NAV database is ensured;
6. appropriate training and checking standards for pilots exist and are implemented;
7. requirements on experience and currency of pilots;
8. availability of operator training programmes;
9. availability of operating procedures and check lists;
10. provision of information (e.g. MMEL and training requirements) from holders of Type Certificates (TC) to air operators, throughout the life cycle of the aircraft is ensured (e.g. through Operational Suitability Data); and
11. AIS information (including NOTAM) is provided by an AIS provider.

It has been considered that if one or more of the above criteria is not met for CAT SET-IMC, then a specific approval might be required. The following assessment has been made:

1. There is currently no airworthiness approval specifically related to SET-IMC operations.
2. These operations are not considered to represent a specific challenge for pilots. It should be noted as well that CAT operations with SET aeroplane are already allowed in VFR.
3. Only a limited experience of CAT SET-IMC exists within Europe since these operations are currently only allowed on an exemption basis. Even if these operations are not new and are conducted since many years in some third countries, Europe has not built so far a large experience in these operations.
4. The proper management of emergency situations is not considered to represent a challenge for pilots, provided that they are adequately trained to handle such situation. The current training requirements are considered to be adequate to handle safely emergency situations. The risk of such operations has been assessed (see paragraph 4.1.2) and found acceptable.
5. CAT SET-IMC operations relies on the selection of safe forced landing area along the route to allow a safe forced landing in case of a loss of power. These areas can be an aerodrome but as well any field which has been assessed by the operator as allowing a safe forced landing. These areas are selected by the operator and have to be introduced in the navigation system by the operator itself and, therefore, the integrity and accuracy of the whole navigation database can’t be insured through a the letter of acceptance (LoA) of the navigation database supplier as stated in AMC1 CAT.IDE.A.355.
6. It is considered that the current training standards already provide a solid basis to operate CAT SET-IMC and to handle emergency situations.
7. Single-pilots CAT SET-IMC operations are required to meet ORO.FC.202 requirements related to single-pilot operations in IFR or at night, but there is currently no specific requirement for CAT SET-IMC. The JAA NPA OPS 29 Rev 2 was not as well foreseeing any additional experience requirements for these operations.
8. Specific training items for CAT SET-IMC have in any case to be included in the operator training programme approved by the competent authority.

9. The procedures related to CAT SET-IMC have in any case to be included in the operations manual which is submitted to the competent authority and distributed to the pilots.
10. As stated in 1., there is currently no airworthiness approval related to CAT SET-IMC operations. It is considered, nevertheless, that the current data provided by TC holders are sufficient since as stated above CAT SET-IMC doesn't represent a specific challenge and doesn't rely on a specific technology. In addition, the necessary training for such operations is considered to be already adequately covered.
11. As stated above, the operator might selected safe forced landing areas which are not aerodromes and therefore it would be impossible to get information from an AIS provider for such fields.

Although most of the elements would speak against a SPA approval, the rulemaking group considered that these type of operations are 'new' in the majority of Member States and a wide experience has not been built yet in Europe. It is, therefore, felt that these type of operations need a stricter form of oversight which is why it is proposed to include them in SPA.

4.3.1.3 Risk period

The maximum total duration of the risk period to be possibly used during CAT SE-IMC operations has been transposed in an AMC to allow some flexibility by providing the possibility to define an AltMOC allowing and to meet the objective of the implementing rule with an equivalent level of safety. This could for example be used in the case of a specific engine with a reliability rate much better that the target one on which the assessment of the safety rate of CAT SET-IMC operations has been based.

4.3.1.4 Requirements outside the scope of OPS regulation:

All the JAA NPA OPS 29 Rev 2 SET-IMC requirements which are considered to be outside the scope of the OPS regulation have been assessed to check if they are already properly addressed in other regulations (Regulation (EC) No 2042/2003) or CSs (CS-23). This has been identified and, therefore, all the relevant provisions contained there have not been transposed in the proposed draft text.

4.3.2. Option 2 description

Since the independent study performed by QINETIQ is recommending additional mitigations to the JAA NPA OPS 29 Rev 2, it is considered necessary to assess all these recommendations individually.

Table 6: QINETIQ recommendations summary

QINETIQ reference	Description
12.1/9.1	Remove the reference to risk periods/time since it is covered by the risk assessment method
12.1/9.3.1	The minimum crew for night/IMC operations should be mentioned on the operational approval.

12.13	CAT SET-IMC should be conducted with a minimum crew of 2 pilots, unless the operator can demonstrate can be managed by one pilot. (6.3)
12.1/9.4.1	Provide additional guidance related to crew composition
12.2	The operator should be required to perform a risk assessment for each route for which approval is sought. (3.9.5)
12.4	Landing minima: The ceiling restriction for CAT SET-IMC should be not lower than 500 ft/MDH. The minimum visibility should be 1 200 m. (4.2.9)
12.6	The landing distance requirements should be increased to allow the aeroplane to be at 200 ft above the threshold instead of 50 ft during an emergency landing. (4.2.10)
12.1/9.2.1	Area navigation system should be able to calculate and display wind parameters. It should also be capable of displaying the actual height in relation to the height required to glide to the threshold in the prevailing wind (see 12.10)
12.1/9.2.3	Review the additional equipment requirements in relation to paragraphs 3.3 to 3.8 of the report
12.1/9.5.1	The required training should include also engine shut down training in a darkened cockpit
12.11	Training requirements should include training for a loss of power in a darkened cockpit. Training should also emphasize the importance of good CRM. (7.3 and 7.4)
12.12	Training requirements should take into account the rates of travel of flap and undercarriage with stand-by system, if significantly lower than with normal power. (7.2)
12.1/9.2.2	Power should be available for 2 emergency relight attempts, one at high altitude and one at low altitude (9.2.2)
12.1/9.2.4	Modify the emergency electrical supply requirement to mention that it should have no probable or undetectable failures mode.
12.5	Any increase to the maximum stall speed should not lead to a value above 70 kt. (3.8.3)
12.7	De-icing/anti-icing equipment should be still operative after a loss of power when flying in icing conditions. (3.4.5 and 4.2.12)
12.8	During the certification of the aeroplane, a stall should have been demonstrated 'engine off' with the propeller feathered to ensure that there are no significant changes in stall or stall warning characteristics. (3.6.1)
12.9	During the certification of the aeroplane, a static test in a darkened cockpit should be undertaken to simulate the consequence of a loss of power on the systems

	behaviour and on the information provided to the crew. (7.3)
12.10	When approving a type for SE-IMC, the navigation aids should be assessed in flight under simulated IMC to show that they can be programmed, managed and interpreted such that a successful landing with a simulated engine failure can be achieved (3.5.4).
12.15	EASA, in conjunction with the NAAs should record operational experience to possibly simplify acceptance criteria later.
12.3	The operator should provide information on how de-confliction with other traffic is to be achieved in case of a loss of power. (8.3)

It should be noted that QINETIQ recommendation 12.14 has not been included in this list. This recommendation was asking EASA to investigate why the engine failure rate for UK registered twin turbine aircraft below 5 700 kg and powered by PT6 engines in the period 2000 to 2004 (inclusive) was so high (43×10^{-6}). Unfortunately, this rate used by QINETIQ in their report was not referenced and it was not possible to determine the source of information. The UK CAA indicated that they have never provided such data to QINETIQ.

It is, therefore, not possible to make any assessment on the issue mentioned by QINETIQ and this recommendation has consequently not been considered. It should be noted that, in any case, the PWC reliability data for the PT6 fleet operated worldwide was reviewed by the rulemaking group and that there was no indication of any such trend (see summary in appendix K).

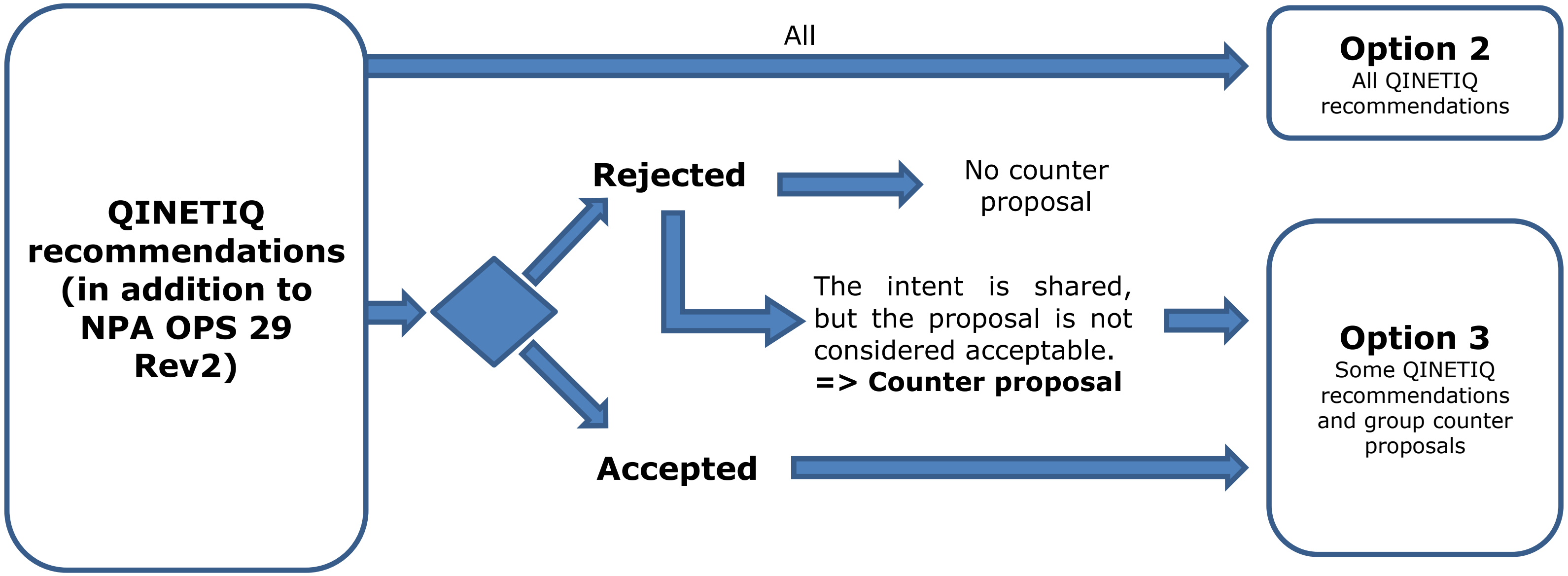
4.3.3. Option 3

4.3.3.1 Approach taken to define option 3

For each of the QINETIQ recommendation, it was assessed whether it was considered:

- acceptable and therefore would provide a positive safety with no major implementation difficulty,
- non-relevant because it is already covered by an existing regulation,
- non-acceptable, because it is introducing implementation, economic or harmonisation issues, but at the same time the intent of the recommendation is found relevant and therefore a counter proposal is proposed to address the issue,
- non-acceptable because of minor or no positive safety benefit and/or implementation/economic/harmonisation issues.

The process used to determine options 2 and 3 is summarised in the following diagram:



To avoid repeating the impact assessment of the QINETIQ recommendations as part of the option 2 and option 3 assessment, this process has been performed once for each recommendation and the results have been directly used in the option 2 and 3 of the impact assessment.

The same principle has been used for the assessment of the impacts of the NPA Ops 29 Rev 2 since this is part of option 1, 2 and 3.

4.3.3.2 Option 3 description

As stated above, option 3 contains, in addition to the NPA OPS 29 Rev 2:

— the QINETIQ recommendations accepted following the assessment performed

— the counter proposal related to some QINETIQ recommendations whose intent was shared but for which it has been identified that it would introduce mainly implementation issues.

This table contains a general assessment of each QINETIQ recommendation. This assessment was the basis for the definition of the counter proposals which are part of option 3. This assessment is further detailed in the paragraphs related to the impact assessment of the options

Table 7: Rational for counter proposals and list of counter proposals part of option 3

QINETIQ reference	General assessment of the QINETIQ recommendations used to determine the need to define a counter proposal.	Counter proposal defined
12.1/9.1	The risk assessment methodology proposed by QINETIQ is considered to be too complex and of limited value especially for a small operators with limited experience and therefore limited data to support it. This is the reason why the concept of risk period is proposed to be kept. Nevertheless, in some cases, this methodology could provide some benefits and, therefore, it is proposed to keep the risk period and to allow operators to supplement it with the risk assessment methodology proposed by QINETIQ. The counter proposal is therefore to keep the risk period as it was proposed in the NPA OPS 29 Rev 2 and to provide guidance to operators related to the use of this risk assessment methodology.	Yes
12.1/9.3.1	The working group considered that no specific requirement should be added in the area of crew composition to the current general requirement contained in ORO.FC.100 and in ORO.FC.202. Consistency should be ensured with these paragraphs and, in addition, no safety benefits are expected based on the assessment of the database of accident (see paragraph 4.5.1.3 for more details). No counter proposal has been drafted for this recommendation.	No
12.13	Same as above.	No
12.1/9.4.1	Same as above.	No

12.2	It is suggested in this QINETIQ's recommendation that an approval is required for each individual route the operator is planning to operate based on a risk assessment performed by the operator. While the group agrees that a robust route analysis is necessary, and that the risk assessment methodology shouldn't be required (see 12.1/9.1 above), the need for an individual approval for each route is not considered to be proportionate and will introduce a large burden on operators and competent authority. It is, therefore, proposed to rather require that the operator performs an analysis for each route to be operated, according to a defined methodology which needs to be approved under the general approval granted to an operator for CAT SET-IMC operations.	Yes
12.4	The intent of the QINETIQ recommendation is understood, but its scope is not clear and, in addition, it might introduce some consistency issues. Indeed, it's only addressing airfields and runway but doesn't specifically mentions landing sites which are in none of these categories. The issue of setting minima for all landing sites is considered impractical since for landing sites which are only fields, no weather information is available and, therefore, it might be impossible in some cases to perform a precise assessment of the expected weather conditions. In order to ensure consistency and to avoid preventing operators from selecting fields as landing sites, it is proposed to draft a new AMC to provide planning best practices related to planning minima without introducing any specific figure.	Yes
12.6	The QINETIQ's proposal to introduce an additional margin to be considered for emergency landings on landing sites was found too complex to be implemented, especially for small operators. It would be quite difficult to perform such calculation for fields with distances estimated from satellite pictures or charts. Finally, it could lead to some unexpected negative impacts on safety since it would reduce the number of available landing sites along the route. The solution proposed by the working group intends to mitigate the risk by highlighting the need of an adequate training to perform zero power landing on an emergency site in IMC/night conditions using the area navigation system information (track and distance to the landing site) and appropriate documentation for determining	Yes

	environmental marks and/or visual cues.	
12.1/9.2.1	It is considered that no technology is currently available to meet this QINETIQ recommendation related to the area navigation system. No counter proposal has been drafted for this proposal.	No
12.1/9.2.3	The different items recommended to be assessed by QINETIQ are considered to be adequately covered by the current certification requirements and, therefore, that no counter proposal is needed.(See appendix F).	No
12.1/9.5.1	It is considered that this QINETIQ recommendation doesn't provide any safety benefit since, in any case, the relevant certification requirement already provide assurance of the availability of adequate emergency power in case of an engine shut-down.	No
12.11	Same as above.	No
12.12	The different items recommended to be assessed by QINETIQ are considered to be adequately covered by the current certification requirements and, therefore, no counter proposal is needed.	No
12.1/9.2.2	This proposal is first considered too prescriptive and in addition is not considered to provide any positive impact on safety. In addition, it is considered that the current certification requirement related to the electrical power management, in case of an engine failure, adequately cover this issue and that, therefore, no counter proposal is needed.	No
12.1/9.2.4	It is considered that the relevant certification requirement cover adequately the QINETIQ proposal related to emergency electrical supply. Moreover, this would also apply to modifications affecting the electrical power system of the aeroplane. It is, therefore, considered that no counter proposal is needed.	No
12.5	CS-23 Amdt. 1 allows the stall speed to exceed 61 kts without limitations with acceptable mitigation in dynamic seat requirements. A review of the National Transportation and Safety Board (NTSB) Accident Database of accident reports involving aeroplanes that have a stall speed above 61 knots show no evidence that there is any measurable difference in	No

	injury or fatality rates to aeroplane occupants or people on the ground related to the differences in stall speed. Other criteria like aeroplane handling or pilot skill differences are considered to have a far greater effect on the outcome of a forced landing. It is as well considered that aeroplane handling requirements are not different for aeroplane with a higher stall speed. It is therefore considered that no counter proposal is needed.	
12.7	It is considered that the airworthiness requirements and guidance material for certification in icing conditions at system and aircraft level (including requirements for the electrical system) provide for a sufficient level of safety (see Appendix H). The group's counter proposal is to highlight the need of an appropriate training as per the AFM procedure since the NPA OPS 29 Rev 2 requirements are considered sufficient.	Yes
12.8	CS-23 already requires for the certification of turbine aeroplanes the determination of stall speed at a power setting to simulate zero thrust. It is considered that the difference in stall characteristic between power off and power to simulate zero thrust is considered to be minimal to null. This is therefore considered to be adequately covered by the current certification requirements and, consequently no counter proposal is needed.	No
12.9	Same as 12.1/9.5.1 and 12.11.	No
12.10	First it should be noted that, in any case, no SE-IMC type certification is foreseen. Regarding the capability of the navigation aids, it is considered that the current applicable certification standards appropriately cover this issue and that, therefore, no counter proposal is needed.	No
12.15	Considering the scope of the competencies attributed to the Agency, its implication in the implementation part is not possible. Nevertheless, it is considered that the recording of experience could provide safety benefits. The group has, therefore, proposed a counter proposal to require operators to make available to their competent authority data related to the CAT SET-IMC operational experience.	Yes
12.3	Since operations of single-engined turbine aeroplanes is already allowed on a non-commercial basis in VFR/IFR or commercially in VFR, it is considered that the current ATC	No

	practices already adequately address the issue mentioned and that, therefore, no counter proposal is needed.	

4.4. Methodology and data

4.4.1. Applied methodology

4.4.1.1 General

Impact assessment is a process to provide justifications supporting a proposal according to 5 logical steps:

Issue analysis	What is the problem?
Objective	What do I want to achieve?
Definition of options	What are the different solutions?
Analysis of options	Which consequences of these solutions?
Conclusion	What do I decide?

These logical steps are also the core headings of the EASA regulatory impact assessment report.

Once the issues have been analysed, the objectives can be defined and options can be proposed to achieve these objectives and solve the issues. The analysis of the impacts of these options can be performed with different methodologies depending on the availability and types of data. In addition, one of the main principles of impact assessment is to provide an in-depth analysis in proportion to the scale of the issue.

Considering the limited availability of data, which in addition are a mixture of qualitative and quantitative types, it was decided to use the multi-criteria analysis (MCA) to assess the options proposed to solve the issues. The following section explains the principles of the MCA and how it was applied in a way that is proportionate to the issues.

4.4.1.2 Criteria for the impact analysis

Multi-criteria analysis (MCA) covers a wide range of techniques that aim at combining a range of positive and negative impacts into a single framework to allow easier comparison of scenarios. Essentially, it applies cost-benefit thinking to cases where there is a need to present impacts that are a mixture of qualitative, quantitative, and monetary data, and where there are varying degrees of certainty. The MCA key steps generally include:

— establishing the criteria to be used to compare the options (these criteria must be measurable, at least in qualitative terms);

— scoring how well each option meets the criteria; the scoring needs to be relative to the baseline scenario;

— ranking the options by combining their respective scores; and

— performing sensitivity analysis on the scoring to test the robustness of the ranking.

The criteria used to compare the options were derived from the Basic Regulation and the guidelines for Regulatory Impact Assessment developed by the European Commission. The principal objective of the Agency is to 'establish and maintain a high uniform level of safety' (Article 2(1) of the Basic Regulation). As additional objectives, the Basic Regulation identifies environmental, economic, proportionality, and harmonisation aspects which are reflected below.

These principles were fully applied for the analysis of the changes related to this RIA. It required the use of detailed scores from -5 to +5 as explained in the following section.

Further to the previous section, the impacts on assessment areas are attributed an equal weight (i.e. 1). Each option is assessed in relation with each criteria (safety, economic, environmental, social, proportionality, regulatory harmonisation). Scores are used to show the degree to which each option achieves the assessment criteria. The scoring is performed on a scale between –5 and +5. Table 8 gives an overview of the scores and their interpretation.

Table 8: Scores for the multi-criteria analysis

Score	Descriptions	Example for scoring options
+5	Highly positive impact	Highly positive safety, social or environmental protection impact. Savings of more than 5 % of annual turnover for any single firm; total annual savings of more than EUR 100 million.
+3	Medium positive impact	Medium positive social, safety or environmental protection impact. Savings of 1–5 % of annual turnover for any single firm; total annual savings of EUR 10–100 million.
+1	Low positive impact	Low positive safety, social or environmental protection impact. Savings of less than 1 % of annual turnover for any single firm; total annual savings of less than EUR 10 million.
0	No impact	
−1	Low negative impact	Low negative safety, social or environmental protection impact. Costs of less than 1 % of annual turnover for any single firm; total annual costs of less than EUR 10 million.
−3	Medium negative impact	Medium negative safety, social or environmental protection impact. Costs of 1–5 % of annual turnover for any single firm; total annual costs of EUR 10–100 million.
−5	Highly negative impact	Highly negative safety, social or environmental protection impact. Costs of more than 5 % of annual turnover for any single firm; total annual costs of more than EUR 100 million.

4.4.2. Data collection

The main issue regarding to the collection of data to support this RIA is related to the type and accuracy of safety data.

Aviation safety data is typically considered to include accident investigation data; incident investigation data; voluntary reporting data; continuing airworthiness reporting data and operational performance monitoring data.

Since CAT SET-IMC are currently only allowed in Europe on an exemption basis by some Member States, the available data within Europe is not considered to be large enough to be able to perform any relevant and statistically accurate analysis.

This is the reason why most of the safety data that have been collected for this RIA are operational data coming from the USA or Canada. In addition to the data considered at the time JAA NPA OPS 29 Rev 2 was processed, the results of the EASA 2007 QINETIQ study, the extensive data provided by Pratt&Whitney (PWC) and an independent study conducted by Breiling Associates have been considered.

These data qualify as being statistically representative of the wide spectrum of airframe-engine combinations, actual environmental characteristics, and realistic operational environments

In addition, it should be noted that the PWC data includes flight operations in regions that typically have a significantly worse aggregate accident record compared to Europe including the Caribbean data and Africa. It can easily be argued that considering the more sophisticated aviation oversight system in Europe, including stringent regulations, the endorsement of at least JAA NPA OPS 29 Rev 2 would result in even better safety performance.

Finally, engine overhaul and maintenance is subject to some of the most stringent requirements and oversight in Europe (such as, CAMO), which means that the use of worldwide powerplant reliability would provide the 'worst case' or most conservative baseline for approving the operation.

Having said this, it is a fact that the use of non-European data has long added to the controversy among European regulators with regard to the safety and regulatory review of SET-IMC operations. The Joint Aviation Authorities (JAA) working group on SE-IMC was challenged by several regulators during the activities of the working group and in response comments to the Notices of Proposed Amendments (NPA) about the use of U.S. only data. Similar concerns were raised by Italy and the Netherlands at the European Aviation Safety Agency (EASA) RAG/TAG membership in response to the SET-IMC Concept Paper on which it was consulted in 2013.

The RMT.0232/233 working group has acknowledged the importance of this matter and has elected to provide a detailed review of the use of data; the data sources and use of data during the aircraft initial certification, the importance of using non-European aviation safety data in combination with European safety data for SET-IMC analysis and monitoring; and how the data requirements proposed by the rulemaking group would assist in improving safety data over time.

The term 'data' is used somewhat loosely in the debate about SET-IMC. In today's Safety Management Environment the term data and specifically aviation safety data has taken on a new meaning. The rulemaking group notes that operational 'data' is not a homogenous item, but includes (1) powerplant reliability data; (2) event data; and (3) accident data (both fatal and non-fatal accidents), and (4) aggregate flight exposure data (that is, the number of hours flown by single-engined turbine aeroplanes). The different sets of data should be considered individually for the benefit of using non-European/worldwide aviation safety data about SET-IMC operations.

1. **Powerplant Reliability Data** – The engines used in the typical SET-IMC operations are operated around the world and are mostly agnostic to the region of the world in which they are being flown. It is, however, well established that the European engine

overhaul and maintenance requirements exceed the requirements in many countries (such as, the requirement for maintenance has to be performed under the supervision of a CAMO). Similarly, the oversight of maintenance within Europe is more systematic for turbine aeroplane operators compared to many other jurisdictions. It can be expected that the worldwide powerplant reliability would be a 'worse case' powerplant reliability rate compared to Europe and provide a more conservative (that is, lower reliability) than Europe by itself if used for rulemaking. As a result, by using worldwide powerplant reliability to make the case for CAT SET-IMC, EASA would likely ensure that its safety justification is a 'worst case' scenario.

2. **Event Data** – Aircraft and engine manufacturers monitor and collect event data and service information from around the world to help inform their continued operational safety monitoring. The working group was presented with a detailed review of PWCs ongoing analysis of worldwide event data for its installed engines and examples of how the company conducts root cause analysis and introduces safety mitigations based on what is learned from the analysis of the event data. As an example, PWC presented the results of their analysis of events (and trends) that are commonly seen in data from operators that conduct max-performance take off operations as part of island operations. This event data may be atypical to more common SET-IMC operations, but helped inform the aggregate operational experience and enabled the company to introduce mitigations including equipment changes and improved training. If the Agency was not to include this atypical event data (which may not represent European operations), it would not benefit from this experience as part of its responsibilities for safety of European operation. The Agency would be placed at a disadvantage in its oversight of CAT SET-IMC by not being able to use the worldwide lessons-learned and experience in informing European pilots and maintenance training organisations.

3. **Accident Data** – Aircraft and engine manufacturers, like in the case of (2) 'Event Data', monitor and collect accident data from around the world as part of their continued operational safety programs and in cooperation with accident investigation authorities. The Agency accessing the result of the worldwide accident data and information is an important mechanism by which the agency can stay abreast of safety issues that may help predict possible safety issues in the European environment. The lessons learned from accident analysis from around the world should be considered by the Agency as part of its safety oversight of the European SET-IMC operations to ensure that any training, maintenance or operational issues help inform European operations.

When it comes to using aviation safety data from around the world (and not just Europe), it is the view of the working group that it is essential that powerplant reliability data, event data, and accident data from around the world must be considered, analysed and used in context of European aviation safety.

4. Flight Exposure Data – The controversy and remaining issue of using flight exposure data, that is 'hours flown' or 'number of flights/cycles', from outside Europe is in part a Catch-22 situation. Flight exposure data serves as the denominator for any rate analysis such as the establishment of a fatal accident rate. At the current time, Europe does not have CAT operators that conduct single-engined turbine aeroplane operations in IMC/at night with the exception of a handful of operators that have obtained an exemption. In the aggregate, the existing operators only accumulate limited hours each year which is too limited to use for statistically acceptable exposure data in accident rate or event rate analysis. Europe will not be in a position to build significant CAT SET-IMC exposure data without enabling wider operations.

To address the issue of building European flight exposure data, the rulemaking group has recommended the collection of CAT SET-IMC operational data. Additionally, operators will be required to conduct engine data trend monitoring as part of their safety system.

However, the rulemaking group has been presented with approximately 10 million hours of single-engined turbine flight data courtesy of PWC. This exposure data combined with worldwide event and accident data points to a powerplant reliability rate and a fatal accident rate that not only meets, but exceeds the proposed safety target of the EASA NPA (See 4.1.2.2) and other safety analysis.

In addition to the 'operational data' described above, it is considered valuable to have an insight of the data sources and use of data from the perspective of the aircraft initial certification.

Like many other human activities, flying is exposed to hazards. Technology is a way to cope with hazards and' inevitably, at the same time, a source of additional hazards. The aviation community has the vital objective of managing the risks associated with the hazards it is exposed to.

Airworthiness certification specification CS 23.1309 (and similarly 25./29.1309) requires to carry out a systematic review of all aircraft's systems 'to determine if the aeroplane is dependent upon its function for continued safe flight and landing and, for an aeroplane not limited to VFR conditions, if failure of a system would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions'.

There are several ways to show compliance with this requirement and they vary depending on systems' complexity and level of technology. In the case of SE-IMC aeroplanes, the guidance material (GM) providing some guidance on how to show compliance with 23.1309 can be summarised as follows:

— FAA AC 23.1309-1E, System safety analysis and assessment for Part 23 airplanes.

— ARP 4761, Guidelines and methods for conducting the safety assessment process on civil airborne systems and equipment.

— ARP 4754/A, Guidelines for development of civil aircraft and systems.

The safety assessment process is of fundamental importance in establishing appropriate safety objectives for the systems and determining that their implementation satisfies these objectives.

This process has evolved significantly in the last 15 years and, in the meantime, it can be stated that it is well established and has proven its effectiveness and robustness in many certification projects ranging from small to large aircraft.

It mainly consists of the following steps:

- 1. Identification of failure conditions (FC);

- 2. Assessment of FCs severity;

- 3. Assessment of FCs probability.

One key-stone of the system safety analysis and assessment is the functional hazard assessment (FHA). The FHA is defined as a systematic, comprehensive examination of functions to identify and classify failure conditions of those functions according to their severity. The classification of these failure conditions establishes the safety requirements (reliability and development assurance level requirements) that an aircraft and its systems must meet.

It's important to highlight some background information about the methodology used to conduct a system safety analysis and assessment.

In this context Risk is defined as the product of the probability of occurrence of a failure condition (FC) and its severity. In assessing the FCs and their possible consequences the flight phase and relevant adverse operational or environmental conditions or external events need to be taken into consideration. The severity of a failure condition is established based on its effect(s) on the flight crew, the aircraft's occupants, and the aircraft.

When it comes to assessing probability figures, current practices are to take quantitative targets from the applicable acceptable means of compliance and guidance material (e.g. AC 23.1309 and AC/AMC 25.1309) or from a knowledge of actual accident rates.

In this respect AMC 25.1309 addresses the issue of 'data sources' and indicates that 'Where it is not possible to fully justify the adequacy of the safety analysis and where data or assumptions are critical to the acceptability of the failure condition, extra conservatism should be built into either the analysis or the design. Alternatively any uncertainty in the data and assumptions should be evaluated to the degree necessary to demonstrate that the analysis conclusions are insensitive to that uncertainty.

Concerns have been raised by several stakeholders on the adequacy of data used to assess the outcomes of FCs and the possibility to properly take into account events occurring in a 'hostile environment'. It is considered that 'hostile environment' as defined in UK CAA document CAP 686 adequately addresses the concerns related to the need to carry out a force landing in areas geographically unsuitable or in congested areas. A hostile environment is defined as an environment in which a safe forced landing cannot be accomplished because the surface is unsuitable or the aircraft occupants cannot be adequately protected from the elements or search and rescue response/capability is not provided consistent with anticipated exposure or there is unacceptable endangering of persons or property on the ground.

In any case, the following areas are considered hostile:

a) For overwater operations, the open sea areas North of 45N and South of 45S; and

b) Those parts of a congested area without adequate safe forced landing areas.

As mentioned above, when assessing the severity of a FC, existing GMs require to evaluate its effect(s) on the flight crew, the aircraft's occupants, and the aircraft. It has to be noted that the intent of the initial airworthiness certification is to demonstrate that a product complies with specific safety requirements, and that these are satisfied in a given envelope as defined in the aircraft Type Certificate and AFM. Unless otherwise requested or needed, aircraft are meant to be certified for unrestricted operations. Hence a factor such as the hostile environment or, more generally the 'area of impact' in case of an accident, cannot be a factor for airworthiness since this would almost certainly result in some limitations that would negate the initial intent to achieve an approval without operational restrictions. In other words, there's no failure condition assessed during the safety assessment that is supposed to achieve a target of 10E-6 in one geographical region and, say, 10E-7 in a different one for whatever reason.

Nevertheless, to take into account the concerns mentioned above, it is considered that by reviewing different sources of accident statistics in terms of fatalities on the ground, it is possible to get a fair idea of potential significant differences that may be caused by the set of data used or by the population density of different geographical regions. The idea being that, if population density affects safety records, then a region with supposedly higher population density should also experience a higher number of ground fatalities.

As a second step, by comparing these results among different aircraft categories, it is possible to infer whether a specific aircraft category and the relevant type of operations may lead to different results.

To this aim, the following data sources have been considered:

— EASA Annual Safety Review 2012

— NTSB aviation accident database

— NTSB Aviation Statistical Reports

Table 9 – GA accident statistics (5-year average)

	EASA Annual Safety Review 2012 (2007-2011)		**NTSB database (2007-2011)**
	Below 2,25 t	**Above 2,25 t**	
Average No. accidents/year	1035.6	11,8	1521
Average Fatal injuries on board/year	239	11,2	466.2
Average No. of ground fatalities	2.4	0	7,4

Table 9 illustrates the accident statistics for general aviation (GA) aircraft.

General aviation means, in the EASA context, all civil aviation operations other than commercial air transport or aerial work operations, while in the NTSB context it can be described as any civil aircraft operation that is not covered under 14 Code of Federal Regulations (CFR) Parts 121, 129, and 135, commonly referred to as commercial air carrier operations.

The NTSB data refer to US registered GA aircraft.

This table clearly shows that Europe has a ration number of fatalities on the ground/number of accident much lower than the US which doesn’t indicate any density related issue.

Table 10 – CAT accident statistics (10-year average)

	EASA Annual Safety Review 2012 (2001-2010)	**NTSB database (2002-2010)**
Average No. accidents/year (10 year average)	25.2	34.8
Average Fatal injuries on board/year	77.8	17.7
Average No. of ground fatalities	0.8	0.8

NOTE: NTSB data for year 2001 is excluded since related to events mainly caused by an illegal act.

Table 10 illustrates the accident statistics for commercial air transport (CAT) aircraft.

EASA Annual Safety Review refers to 'Number of CAT accidents, fatal accidents and fatalities for EASA MS operated Aircraft Above 2 250 kg MTOM'. The NTSB data refer to U.S. Air Carriers Operating Under 14 CFR 121, Scheduled and Non-scheduled Service (Airlines).

These sources do not provide the number of 'Average No. accidents/year with ground fatalities' but the 'Number of ground fatalities'. For these analyses it is conservatively assumed that the number of accidents with ground fatality is equal to the number of ground fatalities.

The data in Table 9 show that the amount of ground fatalities is very small compared to the amount of fatalities aboard and the average number of accidents per year with ground fatalities is a small fraction of the total average number of accidents/year. Based on these figures it can be inferred that the risk for people on the ground is generally low and that the difference between European and US data are negligible.

Although the data in Table 10 show results with a different scale, it is interesting to observe that the difference between European and US data are statistically negligible, hence confirming the outcomes of the first comparison.

It's worth remarking that, particularly in the case of CAT, accidents with fatalities mainly happen in the vicinity of an airport, which means likely in congested areas. However, the results do not suggest any significant difference that could be attributed to population density.

In summary, the analyses show that the results are statistically insensitive to the data set used to make the comparisons and do not indicate a dependency from the population density of different geographical regions.

Finally, it is noted that the combination of forced landing in an area geographically unsuitable and congested is not relevant as it is reasonable to assume that an inverse relationship exists between these environment characteristics.

An additional analysis has been conducted to assess the sensitivity to the difference in population density between Europe and other parts of the world. According to

EUROSTAT the population density of the EU was 116.92 inhabitants per square kilometre. The United States population density was 87.4 inhabitants per square mile (that is, 33.9 inhabitants per square kilometre) and Canada's population density is 3.7 per square kilometre. This means that on the aggregate Europe has a population density that is approximately 3.5 times higher than the United States.

However, when looking at equivalent parts of Europe and the United States (see, Appendix E), it must be noted that locally there are more similarities than differences. Examples at the top of a ranked list of EU countries, U.S. states, and Canadian show that the U.S. state of New Jersey (461.6 inhabitants per square kilometre) is similar to the Netherlands (494.5 inhabitants per square kilometre). In the middle of the ranked list, the U.S. states of Ohio and Pennsylvania (109.0 and 109.6 respectively) are similar to Portugal (114.5), Slovakia (110.1), Hungary (107.2) and France (103.0). And, toward the lowest ranked population density, Norway (16.2), U.S. state of Oregon (15.4), and the Canadian province of Ontario (14.1) are similar in population density.

One question remains: Is Europe different from the rest of the world so that aviation safety data from other regions is not relevant?

One can answer 'yes', in that Europe is vastly different from many other regions by pointing to Europe having a more stringent oversight system. Additionally, the regulatory framework proposed in JAA NPA OPS 29 Rev 2 (and the one matured through EASA's development of a proposed amendment) not only meets, but exceeds the requirements for CAT SET-IMC operations established in Annex 6 Part I, Amendment 29.

4.5. Analysis of impacts

The impact assessment of the different options selected has been performed taking advantage of the work performed in the RIA supporting this NPA.

It should be noted as well that since the QINETIQ's recommendations and the group's counter proposals have been integrated in options together with the NPA OPS 29 Rev 2, their impacts have been evaluated in comparison to the NPA OPS 29 Rev 2. These parts of the options would come on top of the NPA OPS 29 Rev 2 and, therefore, this was necessary to be able to calculate the global impact of the options.

A study of TCCA has as well been taken into account to assess the impact of the different options. TCCA published in 2007 (Aviation safety Letter TP185) an evaluation to determine whether the regulations published in 1996 has contributed to the reduction of the overall risk for passengers.

The main conclusion of this study is that the introduction of CAT SET-IMC rules has led to:

— A reduction of the controlled flight into terrain (CFIT) and night VFR accidents in air taxi operations,

— A lower level of risk of CAT SET-IMC compared to VFR in marginal conditions due to the operation of more reliable turbine engine compared to piston engines,

— An influence on aeroplane purchase decision in the direction of more reliable and safer turbine aeroplanes.

4.5.1. Safety impact

4.5.1.1 Option 0

Option 0 would not encourage the replacement of old twins piston engine aeroplanes by safer single-engined turboprop aeroplanes. Considering that the safety record of the currently operated twin pistons is expected to be either stable over the year or even getting worse as it is often the case for ageing aeroplanes, the safety impact over the years of option 0 compared to the current situation is considered to be **-1**.

4.5.1.2 NPA OPS 29 Rev 2

Considering the RIA established by the JAA to support the JAA NPA OPS 29 Rev 2 and the risk assessment performed by QINETIQ, it can be concluded that the global impact on safety is at least slightly positive. Compared to the current situation, it is expected that single-engined turbine aeroplanes will replace some twin piston-engined aeroplanes currently operated which have a worst safety record compared to the target set for single-engined turbine aeroplanes. In addition, it is considered that single-engined turbine aeroplanes have at least an equivalent safety record to that of turboprop twins.

In addition, it offers a further potential safety benefit by expanding the controlled environment associated with IFR to encompass a larger flying fleet. This will enhance operational safety and reduce the likelihood of unintended flight into IMC (UIMC) that are a proven contributor to fatal crashes.

Therefore, the safety impact of the NPA OPS 29 Rev 2 is considered to be **+1**.

4.5.1.3 QINETIQ recommendations

Table 11: option 2 (QINETIQ recommendations) safety impacts

QINETIQ recommendation	Safety impact	Rational
12.1/9.1	0	Risk periods and risk assessment methodology. The proposed risk assessment methodology replacing the concept of risk periods is expected to provide almost no positive impact on safety since it is considered too theoretical and too complex for most operators and, in addition, it relies mostly on a subjective evaluation. In addition to that, an unexpected impact is expected with the continuing improvement of a powerplant reliability rate, since it could encourage to use this extra margin to cover the reduction of mitigations means in other areas. Therefore the safety impact of this recommendation is considered to be 0.
12.1/9.3.1 **12.13**	0	Crew composition: The PWC accident (fatal/non-fatal) database (see appendix J) clearly shows that in almost all cases, a second pilot won't have helped to avoid

12.1/9.4.1		fatalities. Regarding the examples where a second pilot could have helped, it is considered that with the appropriate mitigations in the flight planning area, this accident could have been avoided and, therefore, doesn't introduce any justification for a requirement for a second pilot. It can, therefore, be concluded that there is nothing indicating that a single pilot cannot manage the complexities of continued flight and unplanned landing following an engine failure event. Regarding the specific issue of crew incapacitation, taking into account that this event is very unlikely to happen, no positive safety impact is expected. The 3 QINETIQ recommendations in relation with crew composition are therefore considered to provide no impact on safety.
12.2	+1	<u>Individual route risk assessment and approval by the competent authority</u>: A positive safety benefit could be expected from an individual risk assessment performed by the operator for each route using the method proposed by QINETIQ, which could allow the operator to take into account all the characteristics of the planned route for its flight preparation and therefore decide if the flight can be operated safely. Nevertheless, as stated above, it is considered that due to the lack of data, the assessment of the different probability is very subjective and therefore this could completely annihilate the slight positive safety benefit. Regarding the proposal to introduce an individual approval for each intended route to be operated under CAT SET-IMC, it is considered that no positive safety impact is expected, since in any case this process is subject to the competent authority continuing oversight and, in addition to that, the operator's management system should ensure its efficiency. Therefore, the safety impact of this recommendation is considered to be low and is set at +1.
12.4	0	<u>Specific planning minima for landing sites:</u> On one hand a positive safety benefit could be expected in case of an emergency landing on one of the selected landing sites considering the higher weather minima available for the landing. On the other hand, as it was highlighted during the JAA process, this makes the selection of landing sites for which no weather reporting system is available and especially when considering landing sites which are not aerodrome almost impossible. Therefore, to compensate the reduced availability of landing sites,

		operators are expected either to make use of a longer risk period or to use longer routes to ensure the availability of landing site with the appropriate planning minima. As a consequence, no positive safety impact is considered for this recommendation.
12.6	0	Additional landing performance margin: A small positive safety benefit could be expected in case of an emergency landing on one of the selected landing sites. Nevertheless, this could introduce drawback since this would reduce the number of available landing sites for the CAT SET-IMC operators and, therefore, might force these operators to make use of a longer risk period or to plan longer routes with a longer gliding distance to a landing site in case of an engine failure. As a consequence, no positive safety impact is considered for this recommendation.
12.1/9.2.1	+1	Area navigation system with wind parameters and required height in relation to the gliding distance: A positive impact on safety could be expected since it would provide very clear information to the flight crew. Nevertheless, it should be noted that this technology doesn't exist yet and would, therefore, need to be developed. In addition to that, a possible drawback has been identified since it could encourage the use of non-certified portable equipment. As a consequence, the safety impact for this recommendation is considered to be only +1.
12.1/9.2.3	+1	The assessment of this recommendation in Appendix F shows that most of the items are covered by certification requirements. Nevertheless, some of them are considered to have a positive impact on safety and, therefore, the safety impact for this recommendation is considered to be only +1. Since this recommendation is only partly accepted, the resulting part accepted has been integrated in a counter proposal to recommendation 12.1/9.2.3.
12.1/9.5.1	0	Engine shut down training in a darkened cockpit/ Importance of a good CRM: It has to be noted that in any case the current airworthiness regulations already require adequate power to be available and, therefore, the situation which would be required to be trained is almost impossible. The current certification requirements already require that adequate power
12.11	0	

		remains available during a duration of 30 mn (including time for the pilot to take appropriate load shedding action). Regarding the CRM, considering that in any case CRM training requirements are already very detailed in Regulation (EU) No 965/2012 and since a requirement for CRM training exists as well for single-pilot operations, no safety impact is foreseen. As a consequence, no positive safety impact is considered for these two recommendations.
12.12	0	Rates of travel of flaps/undercarriage taken into account in training: It is considered that this is already covered by Regulation (EU) No 965/2012 requirements and especially in paragraph AMC1 ORO.FC.220 for conversion training and checking and in paragraph AMC1 ORO.FC.230 for recurrent training and checking. As a consequence, no positive safety impact is considered for this recommendation.
12.1/9.2.2	0	2 emergency relight attempts: The PWC database related to fatal accidents clearly shows that in all of the cases a second relight attempt had no chance to be successful because of the damages to the engine which led to the engine shut-down. Most of these accidents are consecutive to a loss of power caused by a compressor turbine (CT) blade distress which, therefore, prevented any possibility to restart the engine. Some successful relight attempts have been recorded but it was always at the first attempt. As a consequence, no positive safety impact is considered for this recommendation.
12.1/9.2.4	0	The emergency electrical supply should have no probable or undetectable failures mode: It is considered that the current requirements of CS-23 are already covering the issue intended to be addressed by this recommendation. It is addressed in CS 23.1309. In addition to that, the QINETIQ recommendation doesn't seem to take into account the system architecture and, therefore, is having a too prescriptive approach. For example, depending on the outcome of the safety assessment, it could be acceptable to have probable failure modes as long as they are announced and the main system is sufficiently reliable (so that the overall safety target is achieved) (see appendix G for further explanations).

		As a consequence, no positive safety impact is considered for this recommendation.
12.5	0	Maximum stall speed: It should be noted that the existing certification requirements (Part/CS-23) do not set a maximum value for stalling speed for single-engined aeroplanes. Indeed it only sets a threshold at 61 kts for stalling speeds. For aeroplanes with stalling speeds above this threshold, specific requirements must be complied with to safeguard a forced landing for third parties and aeroplane occupants. As a consequence, no positive safety impact is considered for this recommendation.
12.7	0	De-icing/anti-icing equipment: First of all it has to be noted that in terms of feasibility, for airframe ice protection, no single engine pneumatic boot equipped airplane could meet the proposed requirement (the system either uses engine bleed air or an engine driven air pump). In addition to that, it is considered that CS-23 is already providing a robust approach for a sufficient level of safety. This QINETIQ's recommendation is, therefore, not expected to provide any safety benefit since service experience demonstrates that the airworthiness requirements and guidance material for certification in icing conditions at system and aircraft level (including requirements for the electrical system) provide for a sufficient level of safety. (see appendix H for further explanations).
12.8	0	Stall characteristics with propeller feathered: It has to be noted that CS-23 already requires for the certification of turbine aeroplanes the determination of stall speed at a power setting to simulate zero thrust. In addition to that, the difference in stall characteristic between power off and power to simulate zero thrust is considered to be minimal to null. As a consequence, no positive safety impact is expected for this recommendation.
12.9	0	Static test in a darkened cockpit: This recommendation is not expected to provide any positive safety impact (see rational to QINETIQ's

		recommendations 12.1/9.5.1 and 12.11).
12.10	0	<u>Navigation aids capabilities:</u> It is considered that the current certification requirements for such systems adequately cover this recommendation and that, therefore, no positive safety impact is foreseen.
12.15	+1	<u>Operational experience recording:</u> First of all, it has to be noted that in any case the Agency has no competency regarding the implementation of OPS regulations and therefore can't be involved in the process mentioned by this QINETIQ's recommendation. However, it is recognised that the recording of experience could in any case provide safety benefits and could be helpful for the competent authority as part of its oversight and could as well support further evolution of the CAT SET-IMC rules. As a consequence, the safety impact for this recommendation is considered to be only +1.
12.3	0	<u>De-confliction with other traffic:</u> It has to be noted that currently, non-commercial operations of single-engined aeroplanes in IMC and at night are allowed and that the de-confliction with other traffic is considered to be similar with CAT SET-IMC in case of an emergency. Therefore, since no specific issue has been identified in this area, it is considered that the current ATC practices already address single-engine operations. As a consequence, no positive safety impact is expected for this recommendation.

<u>4.5.1.4 Counter proposals</u>

Table 12: Option 3 safety impacts

QINETIQ recommendation / counter proposal	Safety impact	Rational
12.1/9.1	+1	It is considered that for some operators with adequate experience and resources to perform this exercise, it could provide some safety benefits since it allows the operator to perform a risk assessment on an individual route basis and therefore to evaluate more accurately if the risk is within the acceptable limits. Therefore, the safety impact of this counter proposal is considered to be +1.
12.2	0	Based on the assessment of QINETIQ's recommendation 12.2, it is considered that the approval of the operator's procedure for the route analysis as part of the operator general approval for CAT SET-IMC is considered sufficient to ensure that the operator conducts an efficient analysis of each route it intends to operate. Only a minor safety benefit is foreseen for this counter proposal since in any case the operator is required to perform an analysis of each route, but it will allow its competent authority to receive this procedure together with the operator's application and, therefore, to review it at an advanced stage.
12.4	+1	Since no stringent requirement is possible regarding operating minima at the planning phase for the selection of landing sites, it is considered that some guidance to operator related to the assessment of the weather conditions at these landing sites would allow operators to select a landing site with weather conditions which could forbid a safe forced landing to occur in case of an emergency. Therefore, the safety impact of this counter proposal is considered to be +1.
12.6	0	Training requirements are already sufficiently covered in ORO.FC and it is considered that no additional requirement is necessary. Therefore, only a minor positive impact on safety is foreseen for this counter proposal since it will highlight the need for an appropriate training related to an emergency landing following a loss of power in CAT SET-IMC.

12.7	0	It is considered that the training requirements are already extensively covered in ORO.FC. Therefore, only a minor positive impact on safety is foreseen for this counter proposal since it will only highlight the need for an appropriate training related to emergency descent and landing following a loss of power in icing conditions.
12.15	+1	It is considered that the recording of experience could in any case provide safety benefits and could be helpful for the competent authority as part of its oversight. It could as well support further evolution of the CAT SET-IMC rules. Therefore, the safety impact of this counter proposal is considered to be +1.

4.5.1.5 Conclusion

The following table provides a summary of the different safety impacts identified in the previous paragraphs.

Regarding options 2 and 3, a calculation has been made to take into account all the individual impacts of the different elements of the 2 options and without giving them an unexpected weight compared to the impact of the NPA OPS 29 Rev 2. In the case of option 2, an average value of the individual safety impacts of the QINETIQ's recommendations has been calculated and directly added to the safety impact of the NPA OPS 29 Rev 2 to obtain the estimated safety impact of option 2.

A similar calculation has been made for option 3 with an average impact value calculated first for the counter proposals.

A description of the method used for the calculation is given in the following table:

Table 13: methodology used for the calculation of the global impact of options 2 and 3

		Estimated individual impact	**Global impact of the options**
Option 1	NPA OPS 29 Rev2	n1	$n1 + (\sum_{i=1}^{19} qi\ )/\ 19$
	QR 1 QR 2 QR 3 … QR 19	q1 q2 q3 … q19	

Option 2	NPA OPS 29 Rev2	n1	$n1 + (\sum_{i=1}^{7} ci\ )/7$
	CP 1 CP 2 … CP 7	c1 c2 … c7	

In addition to that, recommendations 12.1/9.3.1, 12.13 and 12.1/9.4.1 have been considered as only one recommendation since they are all related to the same issue (crew composition). Therefore, the total number of recommendations considered is 19.

As a consequence the calculation of this average for option 2 and 3 has been done as follow:

Impact option 2 = impact NPA OPS29 + SUM(all individual impact)/19 = 1 + 4/19 =+ 1.2

Impact option 3 = impact NPA OPS29 + SUM(individual impact)/7 = 1 + 4/7 =+ 1.6

This method has also been used for all the other categories of impact of this RIA.

Table 14: Safety impacts summary

Options	**Individual safety impact**
Option 0	-1
Option 1 NPA OPS 29 Rev 2	+1
Option 2	
NPA OPS 29 Rev 2	+1
12.1/9.1	0
12.1/9.3.1	0
12.13	
12.1/9.4.1	
12.2	+1
12.4	0
12.6	0
12.1/9.2.1	+1
12.1/9.2.3	+1
12.1/9.5.1	0
12.11	0

12.12	0
12.1/9.2.2	0
12.1/9.2.4	0
12.5	0
12.7	0
12.8	0
12.9	0
12.10	0
12.15	+1
12.3	0
Option 3	
NPA OPS 29 Rev 2	+1
CP 12.1/9.1	+1
CP 12.2	0
CP 12.4	+1
CP 12.6	0
CP 12.7	0
CP 12.15	+1

Table 15: Global safety impact summary.

Options	**Global safety impact**
Option 0	-1
Option 1	+1
Option 2	+1.2
Option 3	+1.5

4.5.2. Environmental impact

Option 1, 2 and 3 are all related to the authorisation of CAT SET-IMC operations and since no specific requirements are contained in the area of environment protection, it is considered that the environmental impact is the same for these three options.

4.5.2.1 Option 0

Option 0 is considered to have no environmental impact.

4.5.2.2 Noise /emission study

The following topics have been considered:

— Noise

— Emissions

— Other environmental impacts (based on RIA for NPA-OPS 29 Rev. 2)

The intent of this study is not to provide an extensive evaluation of the noise and emission characteristics of SET aircraft. It is rather to highlight some characteristics and indicators that are representative of the differences between SET, twin pistons and jet aircraft.

1. Noise

ICAO Annex 16 establishes the noise requirements that have to be complied with by noise-certified aircraft. In the last years, growing consideration has been given to noise generated by aircraft that can affect human health and quality of life and the environment.

One way to illustrate the noise impact generated by an aircraft is by means of Noise Footprints. The model to calculate the noise footprints is based on the acoustical and the take-off performance of the referenced aircraft. The model essentially considers noise levels, performance data, and a pre-defined flight path and uses a mathematical model to produce the noise footprints. This mathematical model only takes into account air attenuation (no ground attenuation) and does not consider any directivity or installation effects. The following data sources were used to calculate the noise footprints illustrated in Figure 2 of Appendix B:

— Swiss Aircraft Noise Database for noise modelling. The data for propeller driven aircraft are based on Annex 16 certification data; those for jet aircraft are based on measurements.

— Performance data. The performance data are taken from the aircraft flight manual (AFM) for propeller driven aircraft and were provided by the aircraft manufacturer for jet aircraft.

— Flight path. An idealised flight track is used consisting of the ground roll, the ground distance corresponding to the take-off up to 15 m (50 ft), and climb at a constant climb angle corresponding to Vy.

Figure 2 shows comparisons among different aircraft normally used, or that could be used, for taxi/charter, shuttle islands, and cargo operations. It has been decided to compare the 80dB(A) at take-off to improve readability and because the corresponding curves fit the purpose of comparing the noise characteristics of several aircraft. It is remarked that only a selection of footprints has been displayed and additional information relevant to some twin-piston aircraft is provided in a different form (see Figure 2 in Appendix B).

Bearing in mind the assumptions and constraints mentioned above, it is possible to infer the following results:

— Overall SET aircraft show relatively small noise footprints resulting in a limited impact on human beings and the environment.

— Twin engine aircraft (piston and turboprop) normally produce a higher noise impact than SET aircraft. However, it is fair to say that the aircraft design peculiarities (such as propeller RPM, propeller dimensions, overall aircraft aerodynamics) can significantly influence the aircraft noise characteristics.

— SET aircraft have a significantly better environmental footprint than jet aircraft.

2. Emissions

ICAO Annex 16 establishes the emission requirements that have to be complied with by emission-certified engines. In the last years, growing consideration has been given to contaminants emitted by aircraft and airport sources that can affect human health and the environment. The Landing and Take-off (LTO) cycle Emissions is a model defined by ICAO and used in the emissions certification procedure to evaluate the environmental performance, compare the technology and check compliance of aircraft engines with the regulatory limits.

Currently, all jet and turbofan engines have to comply with a smoke standard. Jet and turbofan engines above 26.7 kN thrust additionally have to comply with standards for carbon monoxide (CO), unburned hydrocarbons (HC) and nitrous oxides (NOx).

At this time, there is no ICAO gaseous emissions standard for small turbofans (below 26.7 kN thrust) and for turboprops. For the purpose of LTO emission comparison, operating power and times in mode have been adapted for these engine categories as shown in figure 2. Turboprop and small turbofan engine manufacturers usually perform emission testing, although there is no emission certification standard for such engines. Such uncertified engine data (emission factors and fuel flows for defined power settings) have been obtained directly from engine manufacturers by confidentiality agreement and are used in the following emissions comparison.

Although the LTO cycle has been designed solely for emission certification of jet and turbofan engines, it is often used to calculate airport emission inventories as the design of the LTO is related to emissions generated at and around airports up to roughly 3000 ft AGL.

The following has to be considered when assessing the results provided by the model.

The LTO considers four operating modes, power settings and times in mode. (see Figure 1 below). The LTO cycle does not take individual aircraft performance differences into account: LTO emissions are calculated with generic power settings and cycle times. The LTO cycle is engine based, which means that the LTO emission results for a particular engine used in different airframes will be the same, irrespective of the airframe.

Therefore, when comparing aircraft, only qualitative results can be expected. However, the results allow to effectively compare representative indicators and get interesting information on the impact of the different power-plants level of technology. This is typically the case when comparing a relatively new turbofan with a dated turboprop engine which, in some cases, had been certified several decades apart.

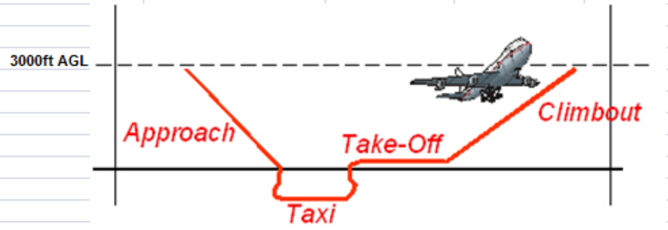
Figure 1 - Landing and Take-off (LTO) cycle Emissions (LTO)

Calculation Model = LTO Cycle

Phase	A/C Type Times in Mode [s]		
	Business	Turboprop	Piston
Takeoff	24	30	18
Climbout	30	150	150
Approach	96	270	180
Taxi	780	780	720

Phase	A/C Type Power Settings (% of max. rated)		
	Business	Turboprop	Piston
Takeoff	100	100	100
Climbout	85	85	85
Approach	30	30	40
Taxi	7	3	13

LTO-Cycle



Appendix C shows several comparisons among different aircraft normally used, or that could be used, for taxi/charter, shuttle islands, and cargo operations.

The rulemaking group selected carbon dioxide (CO2) emissions, which are basically proportional to engine fuel burn and are directly related to climate impact .

For health consideration we selected the pollutants carbon monoxide (CO), unburned hydrocarbons (HC), nitrous oxides (NOx) and lead (Pb).

Bearing in mind the assumptions and constraints mentioned above, it is possible to infer some interesting results:

— Overall SET aircraft show relatively low fuel consumption, which also means low CO2, and reduced CO emissions.

— Turbine engines, as opposed to piston engines, do not produce lead emissions.

— The combustion characteristics of a typical air cooled piston engine cause a significant amount of CO and HC. In this respect SET aircraft have a better environmental footprint.

— NOx emissions of SET aircraft will normally be higher than piston engine aircraft since turboprop power-plants feature a much higher combustion efficiency. On the other hand, SET aircraft score better than jet aircraft.

3. Other environmental impacts

On a general basis, the operation of single-engined turbine aeroplanes is expected to lead to a better fuel and oil consumption compared to the old twin engine piston aeroplanes and therefore a positive environmental impact is expected.

4.5.2.3 Conclusion

Based on this study, the overall impact on environment related to the use of SET aeroplanes instead of multi-engine piston or turboprop aeroplanes is considered to be minor but globally positive and therefore the environmental impact of options 1, 2 and 3 is considered to be **+1**.

4.5.3. Social impact

4.5.3.1 Option 0

Option 0 is considered to have no social impact.

4.5.3.2 Options 1, 2 and 3

Option 1, 2 and 3 are considered to have positive social impact since new routes will be operated and new business created and, therefore, new jobs created in relation with these operations.

The SET can offer air services to remote regions and cities with small airfields that are just not available by using road or rail transport or by using other types of aeroplane.

Option 2 is considered to have a slight additional positive social impact since it would lead to the recruitment of more flight crew for these operations since 2 pilots would be required in any case based on QINETIQ recommendation 12.13. However, this slight additional benefit is marginal in comparison with the fact that the new routes will enable to connect quicker remote populations.

Therefore, the social impact is considered to be **+3** for options 1, 2 and 3.

4.5.4. Economic and proportionality impact

Currently all CAT SET-IMC operators allowed under an exemption in Europe are considered to be small operators. In addition, it is likely that, once rules are available, only small operators will start to operate CAT SET-IMC. For this reason, economic impact on operators and proportionality impacts are considered to be very close since proportionality impacts on operators are expected to be mostly financial impacts. Therefore, it has been decided to combine the impact assessments of these 2 categories in order to avoid any redundancy.

4.5.4.1 Option 0

Option 0 is considered to have no economic impact or impact on small and medium enterprises (SMEs).

4.5.4.2 NPA OPS 29 Rev 2

No impact on general aviation is foreseen since the scope is limited to commercial air transport (CAT) operations.

Compliance costs

As stated in the RIA to the JAA NPA OPS 29 Rev 2, it is considered that compliance costs will be minimal. Two manufacturers have confirmed that the additional equipment required for compliance will be less than 5 % of the basic aeroplane cost. In addition to that it should be noted that the latest versions of the main aeroplane types which are expected to be operated in CAT SET-IMC (PC12, C208 and TBM700) are already compliant to most of the NPA OPS 29 Rev 2 in terms of equipment.

As stated above, the EU operators currently authorised to operate CAT SET-IMC flights are only small operators. On general basis it is considered that there is no proportionality issue associated with the NPA OPS 29 Rev2 since it is the basis for several exemptions within Europe. Nevertheless, since some countries have granted CAT SET-IMC approvals based on ICAO Annex 6, the introduction of NPA OPS 29 Rev 2 would have a slight negative impact on these operators since the JAA NPA OPS 29 Rev 2 is more stringent that ICAO Annex 6 Part I provisions for CAT SET-IMC.

Therefore, in the area of compliance costs, the impact is expected to be slightly negative.

Economic benefits

The benefits are also clear since a new class of economical (lower direct and indirect operating costs, see appendix D) aeroplanes will be able to exploit a new market. This will open up new possibilities, the pioneering of new routes and enhancing the economic viability of communities not served well by the current transport infrastructure.

The RIA to the JAA NPA OPS 29 Rev 2 indicated that based on information coming from potential customers for single-engined turboprops (SETs), at least half of sales in Europe would be for new markets, e.g. on routes or for operations not currently economically feasible, or where runways usable for SETs are not adequate for twins. Such operations will provide vital new communications for remote communities not presently served, will reduce the outward drift of the population from such areas, and provide new employment. The capability and enhanced economics of SETs will also provide new opportunities for airfreight and tourist operations in all areas.

In addition, it should be noted that allowing CAT SET-IMC will allow new aeroplane types and new engines to be designed to meet the criteria contained in the NPA OPS 29 Rev 2, which will have in any case a positive economic impact.

Possible competitive disadvantage for certain economic entities

Based on GAMA figures related to the aeroplane fleet in the USA from 1993 onwards for single and twin powered aeroplanes, there is no evidence from these numbers that the introduction of single turboprop aeroplanes has had any impact on the number of twin piston or turboprop powered aeroplanes being operated. There is no reason to believe that the situation in Europe will be materially different.

A small minority of operators of light twins might be affected, putting pressure on them to introduce SET's or more competitive twins. The benefits of SETs indicated above, coupled with their safety benefit relative to twins overall, must make this beneficial to industry and the public. These operators could, of course, switch to a SET fleet, but the impact on twin numbers is not expected to be great and this will be outweighed by the benefits to the industry, the users of more modern and economic aircraft and their customers.

Considering all the arguments developed in this paragraph, the economic impact of the NPA OPS 29 Rev 2 is considered to be **+3**.

4.5.4.3 QINETIQ recommendations

Table 16: option 2 (QINETIQ recommendations) economic impacts

QINETIQ recommendation	Economic/ proportionality impact	Rational
12.1/9.1	-1	On a general basis; no economic impact is foreseen for this recommendation. It is, nevertheless, considered that the risk assessment methodology proposed by QINETIQ is complex and therefore difficult to implement for small operators and especially those without a long experience in CAT SET-IMC.

		The economic/proportionality impact is, therefore, considered to be -1.
12.1/9.3.1 **12.13** **12.1/9.4.1**	-3	The requirement for a second pilot would have a significant economic impact and might in addition lower or even annihilate the potential economic profitability of CAT SET-IMC operations. It would of course be specifically relevant for small operator which are usually hiring only a few pilots. The economic/proportionality impact is, therefore, considered to be -3.
12.2	-3	An individual approval is first of all considered as a significant burden for operators and in addition it prevents an operator from being reactive to customers' requests since outside working hours it would be impossible for the operator to have the route analysis approved. This is particularly relevant for small operators with very often almost no ground staff to perform this activity. The economic/proportionality impact is, therefore, considered to be -1.
12.4	-3	It is considered that, as it was highlighted during the JAA process, it would make almost impossible the selection of landing sites for which no weather reporting system is available and, therefore, reduce the availability of landings site for emergency landings. The consequence is that operator might use longer routes or might even be prevented to operate the planned flights. From a small operator perspective, it would, in addition, introduce a proportionality issue taking into account the need to collect weather information for landing sites where no weather information is not publicly available. The economic/proportionality impact is, therefore, considered to be -3.
12.6	-3	As for the previous recommendation, it is considered that it would reduce the availability of landings site for emergency landings. The consequence is that operator might use longer routes or might even be prevented to operate

		the planned flights. The economic impact is, therefore, considered to be -3.
12.1/9.2.1	-3	First of all, it should be noted that this technology currently doesn't exist yet and would, therefore, need to be developed. It is also expected that it would require significant development cost to have such equipment available. In addition, existing or potential aeroplanes operated would have to be retrofitted, introducing additional cost for all operators. The economic/proportionality impact is, therefore, considered to be -3.
12.1/9.2.3	-1	As stated in the safety impact assessment; most of the items contained in this recommendation are already covered by the current certification requirements. It is considered that the remaining one will provide a negative economic impact since existing or potential aeroplanes operated would have to be retrofitted. It has been considered impractical to fully assess the cost of such equipment since some of them are not currently available and the cost of the remaining equipment are dependent on the current configuration of each aeroplane. This would results in a significant uncertainty and therefore only a global economic impact has been considered. The economic/proportionality impact is, therefore, considered to be -1.
12.1/9.5.1	-1	The economic/proportionality impact of this recommendation is considered to be -1 since it is introducing a new training requirement in a specific environment. This impact is particularly relevant for small operators.
12.11	-1	Same as above
12.12	0	Since it is considered to be already covered in the current training requirements, the economic/proportionality impact is considered to be null.
12.1/9.2.2	-3	This recommendation is considered to be too prescriptive and would, therefore, introduce

		significant implementation costs to demonstrate the conformity with the proposed requirement. The current certification requirements only require that in the event of a complete loss of the primary electrical power generating system, the battery must be capable of providing 30 minutes of electrical power to those loads that are essential to continued safe flight and landing. The economic/proportionality impact is, therefore, considered to be -3.
12.1/9.2.4	0	Since the issue is considered to be already adequately covered in the current certification requirements, the economic/proportionality impact is considered to be null (See Appendix G for further explanations).
12.5	0	It should be noted that the existing certification requirements (Part/CS-23) do not set a maximum value for stalling speed for SE aeroplanes. It only sets a threshold at 61 kts for stalling speeds. For aeroplanes with a stalling speeds above this threshold, specific requirements must be complied with to safeguard a forced landing for third parties and aeroplane occupants. In addition, the 3 main aeroplane types which are currently considered to be able to meet the NPA OPS 29 Rev 2 requirements have all a stall speed below 70 kts. Therefore, it is considered that the proposed action would have no economic/proportionality impact.
12.7	-3	The QINETIQ recommendation is first considered unclear on what should be still operative after a loss of power and secondly too prescriptive. In most cases, after an engine loss of power, the need for electrical power can be limited to the electrical power for air data probes (airspeed information, stall warning) and to ensure that the pilot is able to see the landing site (windshield de-mist/fog/ice system) (see appendix H for further explanations). The economic/proportionality impact is, therefore, considered to be -3.

12.8	-1	It is considered that this recommendation is mostly covered by existing certification requirements. During the certification process, it is required to determine the stall speed at a power setting to simulate zero thrust and the difference in stall characteristic between power off and power to simulate zero thrust is considered to be minimal to nothing. This requirement would, therefore, add additional compliance cost without providing any benefit. The economic/proportionality impact is, therefore, considered to be -1.
12.9	-1	The proposed requirement would introduce additional tests during the certification process and would, therefore, have a negative economic impact. The economic/proportionality impact is, therefore, considered to be -1.
12.10	-1	The assessment recommended by QINETIQ would require to perform at least one flight test and would, therefore, introduce some additional cost to the operator. The economic/proportionality impact is, therefore, considered to be -1.
12.15	-1	As already stated, it has to be noted that in any case the Agency has no competency regarding the implementation of OPS regulations and, therefore, can't be involved in the process mentioned by this QINETIQ's recommendation. This recommendation is nevertheless considered to have a minor negative economic impact since it would introduce additional administrative work for competent authorities and or operators which would be required to gather information related to their CAT SET-IMC on a regular basis. The economic/proportionality impact is, therefore, considered to be -1.
12.3	-1	This recommendation would require operators to define additional material related to the de-confliction with other traffic in case of an engine loss of power and would, therefore,

		introduce minor additional costs to achieve compliance. The economic/proportionality impact is, therefore, considered to be -1.

4.5.4.4 Counter proposals

Table 17: Option 3 economic/ proportionality impacts

QINETIQ recommendation / counter proposal	Economic/ proportionality impact	Rational
12.1/9.1	0	It is considered that the use of the risk assessment methodology could be beneficial in some cases. As part of its management system, an operator could make use of this methodology to assess the risks of each CAT SET-IMC route to be operated. Since only guidance would be provided, it is considered that the economic/proportionality impact of this counter proposal is null.
12.2	+3	Compared to an individual prior approval for each route intended to be operated by the operator, a positive economic impact is foreseen reducing the burden for competent authorities and providing operators more flexibility to be able to operate new routes at short notice and during the week-end for example. Therefore, it is considered that the economic/proportionality impact of this counter proposal is +3.
12.4	0	The new AMC related to planning minima will provide means to comply with the implementing rule but this it will not introduce an additional requirement, it is not expected to have any economic/proportionality impact.
12.6	0	The new material is intended to highlight the need for a proper training for unpowered landing. This counter proposal is, therefore, expected to have no economic/proportionality impact since this is already addressed in the

		current crew training requirements.
12.7	0	The new material is intended to highlight the need for a proper training for unpowered landing in icing conditions. This counter proposal is, therefore, expected to have no economic/proportionality impact since this is already addressed in the current crew training requirements.
12.15	-1	A minor negative economic impact is foreseen for this counter proposal since it will require operators to gather on a regular basis all the information related to their CAT SET-IMC operations and to produce a report to be sent to their competent authority. Therefore, it is considered that the economic impact of this counter proposal is -1.

4.5.4.5 Conclusion

Table 18: Summary of the economic/proportionality impact

Options	**Individual economic/ proportionality impact**
Option 0	0
Option 1 NPA OPS 29 Rev 2	+3
Option 2	
NPA OPS 29 Rev 2	+3
12.1/9.1	-1
12.1/9.3.1	-3
12.13	
12.1/9.4.1	
12.2	-3
12.4	-3

12.6	-3
12.1/9.2.1	-3
12.1/9.2.3	-1
12.1/9.5.1	-1
12.11	-1
12.12	0
12.1/9.2.2	-3
12.1/9.2.4	0
12.5	0
12.7	-3
12.8	-1
12.9	-1
12.10	-1
12.15	-1
12.3	-1
Option 3	
NPA OPS 29 Rev 2	+3
CP 12.1/9.1	0
CP 12.2	+3
CP 12.4	0
CP 12.6	0
CP 12.7	0
CP 12.15	-1

Table 19: Global economic/ proportionality impact summary.

Options	**Global economic/ proportionality impact**

Option 0	-1
Option 1	+3
Option 2	+1.4
Option 3	+3.3

4.5.5. Impact on 'Better Regulation' and harmonisation

4.5.6.1 Option 0

Option 0 is considered to have no impact on 'better regulation' and harmonisation.

4.5.6.2 NPA OPS 29 Rev 2

ICAO Annex 6 Part I SARPs related to CAT SET-IMC are already available and applicable since 2005. The NPA OPS 29 Rev 2 has been assessed to be more stringent than the ICAO SARPs. Therefore, the NPA OPS 29 Rev 2 would allow Member States to be ICAO compliant.

As stated in the introduction, other third countries have already allowed CAT SET-IMC operations based on national regulations. These regulations are, nevertheless, non-harmonised and range from standards below ICAO Annex 6 SARPs to standards similar to the NPA OPS 29 Rev 2. Therefore, even if there would be no complete harmonisation in the area of CAT SET-IMC, the introduction of the NPA OPS 29 Rev 2 would provide a EU regulatory framework for such operations and provide some harmonisation with the other major third countries which are already allowing CAT SET-IMC operations.

Since the content of the NPA OPS 29 Rev 2 is already used by some French operators (the exemptions granted are based on a transposition of the JAA NPA in a French 'instruction'), and taking into account that no specific implementation issue has been identified, it is considered that no implementation issue is expected related to the introduction of NPA OPS 29 Rev 2.

Therefore, the impact on 'better regulation' and harmonisation is considered to be +1.

4.5.6.3 QINETIQ recommendations

Table 20: option 2 (QINETIQ recommendations) impact on 'better regulation' and harmonisation

QINETIQ recommendation	Better regulation and harmonisation	Rational
12.1/9.1	-1	On one hand, it is considered that this recommendation provides some positive harmonisation since the concept of the risk period is neither contained in ICAO Annex 6

		provisions for CAT SET-IMC, nor in FAA, TCCA and CASA regulations. There is either no limitation on the route selected, or a time limitation from a suitable landing site. Nevertheless, on the other hand, the introduction of the risk assessment methodology proposed by QINETIQ to replace the risk period principle is considered to introduce a bigger negative impact on harmonisation since no such methodology exist in any of these regulations. It is, therefore, considered that this recommendation would provide a minor negative impact on harmonisation of -1.
12.1/9.3.1	-3	ICAO SARPs and FAA/CASA regulations for CAT SET-IMC don't have any requirement for a second pilot and, therefore, this recommendation is considered to have a negative impact of -3 on harmonisation.
12.13		
12.1/9.4.1		
12.2	-1	This risk assessment per route to be operated is not required by the ICAO SARPs nor by the FAA regulation for CAT SE-IMC. It is nevertheless required under the CASA regulations in Australia for routes along which a landing site is not available at a gliding distance. In addition to that, these specific routes need to be individually approved . The impact on harmonisation is, therefore, expected to be -1.
12.4	-3	No such requirements are contained in ICAO SARPs nor in FAA/CASA regulation for CAT SET-IMC. Therefore, this recommendation is considered to have a negative impact of -3 on harmonisation.
12.6		
12.1/9.2.1		
12.1/9.2.3	-1	Same as above, but the foreseen new requirement is considered less stringent and, therefore, the impact on harmonisation is expected to be -1.
12.1/9.5.1		
12.11		
12.12	0	This recommendation is already covered in the general training requirement and, therefore,

		doesn't introduce any harmonisation issue.
12.1/9.2.2	-3	No such requirements are contained in ICAO SARPs nor in FAA/CASA regulation for CAT SET-IMC. Therefore, this recommendation is considered to have a negative impact of -3 on harmonisation.
12.1/9.2.4		
12.5		
12.7		
12.8		
12.9		
12.10		
12.15	-1	Less detailed requirements for regular reporting are contained in ICAO Annex 6 SARPs and in the CASA regulation for CAT SET-IMC, but not in the FAA regulation. Therefore, this recommendation is considered to have a negative impact of -1 on harmonisation.
12.3	-3	No such requirements are contained in ICAO SARPs nor in FAA/CASA regulation for CAT SET-IMC. Therefore, this recommendation is considered to have a negative impact of -3 on harmonisation.

4.5.6.4 Counter proposals

Table 21: Option 3 'better regulation' and harmonisation impact

QINETIQ recommendation / counter proposal	Better regulation and harmonisation	Rational
12.1/9.1	0	This counter proposal would provide some harmonisation with the CASA regulation requiring a risk assessment on certain routes and would at least be consistent with the ICAO SARPs. Therefore, the harmonisation impact is globally considered to be null.

12.2	0	Compared to the NPA provisions, this recommendation is not expected to have any harmonisation impact.
12.4		
12.6		
12.7	0	Compared to the NPA provisions, this recommendation is not expected to have any harmonisation impact.
12.15	-1	Less detailed requirements for regular reporting are contained in ICAO Annex 6 SARPs and in the CASA regulation for CAT SET-IMC, but not in the FAA regulation. Therefore, this recommendation is considered to have a negative impact of -1 on harmonisation.

4.5.6.5 Conclusion

Table 22: Summary of the impacts on better regulation and harmonisation.

Options	**Individual better regulation and harmonisation impact**
Option 0	0
Option 1 NPA OPS 29 Rev 2	+1
Option 2	
NPA OPS 29 Rev 2	+1
12.1/9.1	-1
12.1/9.3.1	-3
12.13	
12.1/9.4.1	
12.2	-1
12.4	-3
12.6	-3

12.1/9.2.1	-3
12.1/9.2.3	-1
12.1/9.5.1	-1
12.11	-1
12.12	0
12.1/9.2.2	-3
12.1/9.2.4	-3
12.5	-3
12.7	-3
12.8	-3
12.9	-3
12.10	-3
12.15	-1
12.3	-3
Option 3	
NPA OPS 29 Rev 2	+1
CP 12.1/9.1	0
CP 12.2	0
CP 12.4	0
CP 12.6	0
CP 12.7	0
CP 12.15	-1

Table 23: Summary of the global impact on 'better regulation' and harmonisation.

Options	Global impact on better regulation and harmonisation

Option 0	0
Option 1	+1
Option 2	-1.2
Option 3	+0,8

4.6. Comparison and conclusion

4.6.1. Comparison of options

The following table provides a summary of the different impacts of each option, with a total impact as a sum of these individual impacts.

Table 24: Global summary of all the impacts.

	Option 0	Option 1	Option 2	Option 3
Safety impact	**-1**	**+1**	**+1.2**	**+1.5**
Environmental impact	**0**	**+1**	**+1**	**+1**
Social impact	**0**	**+3**	**+3**	**+3**
Economic/ proportionality impact	**-1**	**+3**	**+1.4**	**+3.3**
Impact on 'better regulation' and harmonisation	**0**	**+1**	**-1.2**	**+0.8**
Total	**-2**	**+9**	**+5.4**	**+9.6**

Based on this assessment, it is considered that option 3 is the option providing the best global positive impact compared to the other options.

4.6.2. Monitoring and ex post evaluation

The need for monitoring and ex post evaluation of the implementation of the new provisions for CAT SET-IMC operations will be determined based on the results of the NPA consultation.

5. References

5.1. Affected regulations

Commission Regulation (EU) No 965/2012 of 5 October 2012 as last amended laying down technical requirements and administrative procedures related to Air Operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

5.2. Affected CS, AMC and GM

Decision 2012/016/R of the Executive Director of the European Aviation Safety Agency of 25 October2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 05 October 2012 laying down technical requirements and administrative procedures related to Air Operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

Decision 2012/017/R of the Executive Director of the European Aviation Safety Agency of 24 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 05 October 2012 laying down technical requirements and administrative procedures related to Air Operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

Decision 2012/019/R of the Executive Director of the European Aviation Safety Agency of 24 October 2012 on Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 965/2012 of 05 October 2012 laying down technical requirements and administrative procedures related to Air Operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

5.3. Reference documents

ICAO Annex 6 Part I

Certification Specifications for normal, utility, aerobatic and commuter category aeroplanes - CS-23

CFR Part-23 – Airworthiness standards: Normal, utility, acrobatic and commuter category airplanes

FAA Advisory circular AC 25.1309, System design and analysis

QINETIQ report QINETIQ/EMEA/IX/CR0800029/2 'Risk assessment for European Public Transport Operations using Single Engine Turbine Aircraft at Night and in IMC

JAA NPA OPS 29 Rev 2

Breiling 2012 Annual Single Turboprop Powered Aircraft Accident Review

6. Appendices

6.1. List of abbreviations

AC	Advisory Circular
AFM	Aircraft Flight Manual
AMC	Acceptable Means of Compliance
CAMO	Continuing Airworthiness Management Organisation
CASA	Civil Aviation Safety Authority (Australia)
CAT	Commercial Air Transport
CFIT	Controlled Flight Into Terrain
CFR	Code of Federal Regulation
CO	Carbon Monoxide
CRD	Comment Response Document
CRM	Crew Resource Management
CRT	Comment response Tool
CS	Certification Specification
EC	European Commission
EGME	Ethylene Glycol Monomethyl
ETSO	European Technical standard Order
EU	European Union
FAA	Federal Aviation Administration
FC	Failure Condition
FHA	Functional Hazard Assessment
GA	General Aviation
GM	Guidance Material
HC	Hydrocarbon
ICAO	International Civil Aviation Organisation
IFR	Instrument Flying Rules
IMC	Instrument Meteorological Conditions
IPS	Ice Protection Systems
IR	Implementing Rule
JAA	Joint Aviation Authority
LTO	Landing and Take-Off
MCA	Multi-Criteria Analysis

MDH	Minimum Descent Height
METAR	Meteorological Aerodrome Report
MTOM	Maximum Take-Off Mass
NAA	National Aviation Authority
NOx	Nitrous Oxides
NPA	Notice of Proposed Amendment
NTSB	National Transportation Safety Board
OPC	Operator Proficiency Check
PWC	Pratt & Whitney Canada
RIA	Regulatory Impact Assessment
RMT	Rulemaking Task
RVR	Runway Visual Range
SARPs	Standard and Recommended Practices
SET	Single-Engined Turbine Aeroplane
SID	Standard Instrument Departure
SME	Small and Medium Enterprise
STAR	Standard Terminal Arrival Route
STC	Supplemental Type Certificate
STOL	Short Take-Off and landing Aircraft
TAF	Terminal Aerodrome Forecast
TCCA	Transport Canada Civil Aviation
TCH	Type Certificate Holder
TEL	Tetraethyl Lead
UIMC	Unintended Flight Into IMC
VFR	Visual Flying Rules
VMC	Visual Meteorological Conditions

6.2. Appendix A: Safety risk assessment

The following table has been used for each scenario considered.

Scenario X	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
All the scenarios are considering first the engine loss of power together with an escalation factor which is expected to increase the risk of having an unsuccessful emergency landing (with fatalities).		*The main consequences of the loss of power + escalation factor are presented in this column.*	*An evaluation of the risk (of having fatalities) is given considering no specific mitigation other than the standard one for CAT operations.*	*This column presents the mitigations contained in the NPA OPS 29 Rev 2 in relation with the scenario.*	*A second evaluation of the risk is provided taking into account the mitigations proposed by the NPA OPS 29 Rev 2.*

The different scenarios are considered to be a combination of an initial event and an escalation factor.

Escalations factors are conditions/factors which may weaken the effectiveness of a preventive control or recovery measure (source ICAO SMM).

The initial event considered for the safety risk assessment performed is the loss of power, as it is the most relevant one for CAT SET-IMC.

As stated above, it was considered necessary to consider this initial event in combination with several individual different escalation factors to take into account conditions which can likely be encountered during CAT SET-IMC operations.

Nevertheless, it should be noted that each scenario is a combination of the initial event with only one escalation factor since it is considered that the probability of having several escalation factors would be lower and, therefore, would lead to lower fatal accident probabilities.

During its work, the JAA made an estimate of the proportion of fatal accidents following an engine failure. Based on statistical data, in only 12 % of the forced landings, it has resulted in fatalities (see RIA to JAA NPA OPS 29 Rev 2). This observed rate has been used as a conservative value for most of the scenario assessed below. In some cases, considering, the potential higher difficulty a pilot might face, this rate has been increased to 24 or 50 %.

Scenario 1	**Escalation factor (EF)**	**Consequences**	**Risk evaluation**	**JAA NPA OPS 29 Rev 2 Mitigations**	**Residual risk evaluation**
Loss of power ($10x10^{-6}$)	Icing conditions (45 %)*	Loss or degradation of IPS capabilities Ice accumulation on some aircraft surfaces Insufficient performance and/or degraded handling qualities Aircraft loss of control Crash with fatalities	$4,5x10^{-6}$ x 12 %** = **<u>$5,4 \times 10^{-7}$</u>**	1. Two separate electrical generating systems [..] 2. An emergency electrical supply system (battery) [..]	$5,4x10^{-7}$

* Conservative figure extracted from DOT/FAA/AR-05/24 'An inferred European Climatology of Icing Conditions, Including Supercooled Large droplets. As it is stated in this document 'the vast majority of these events do not result in accidents' and 'A very unique combination of meteorological conditions and aviation parameters must occur for the icing to contribute to an accident'.

** JAA estimated on fatal accident rate following a forced landing.

<u>Conclusion:</u>

Service experience demonstrates that the existing airworthiness requirements for certification in icing conditions, at system and aircraft level (including requirements for the electrical system), provide for a sufficient level of safety.

It is noted that the certification in icing conditions does not solely rely on having a fully operational IPS to achieve a continued safe flight and landing. Rather it demonstrates that the aircraft features adequate performance and handling qualities and that sufficient energy is available to supply the systems necessary to carry out the relevant emergency procedures and ensure a safe landing. The need for electrical power can be different from aircraft to aircraft; however it can be summarized as the electrical power needed to protect air data probes (airspeed information, stall warning) and to ensure that the pilot is able to see the landing site (windshield de-mist/fog/ice system).

Therefore, it is considered in this case that the risk level is acceptable. Service experience shows that crew proficiency in the use of AFM procedures applicable to flight in conditions conducive to icing and in icing conditions effectively contributes to safe operation. As additional mitigation means these topics should be emphasised during initial and recurring training.

Scenario 2	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Low visibility at departure (RVR below 1500 m) (2,28 %)*	Inability to identify a possible emergency landing site and avoid obstacles Crash with fatalities	$2,28x10^{-7}$ x 24 %** = $5,47x10^{-8}$	Minimum RVR value of 800 m (or lower based on a case by case risk assessment). Some additional conditions (e.g ceiling) can be specified if there a particular need to see and avoid obstacles.	$(2,28-1,25)x10^{-7}$*** X 24 % =$2,47x10^{-8}$

* yearly occurrences of a RVR below 1 500 m in AMS ('Climatology of low visibility for Amsterdam Airport Schiphol', Amsterdam Airport Schiphol). Different figures might be observed in other parts of Europe, but is is considered that on an average basis, AMS weather conditions are representative of European weather conditions taking into account its location.

** To take into account the higher risk linked to the low visibility in such a situation, the fatal accident rate has been doubled compared to the JAA observed rate for all causes.

*** The probability calculated is the one related to an RVR between 1 500 m and 800 m in AMS.

<u>Conclusion:</u>

It is considered that a RVR value above 800 m should provide the flight crew with equivalent chances to perform a successful emergency landing right after the take-off compared to a VFR flight. Therefore, it is considered that no additional mitigation is needed.

Scenario 3	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Low visibility at the planned landing site (RVR below 550 m or ceiling below 200 ft) (3 %)*	Late visual acquisition of the landing site Unstabilised approach Crash with fatalities	$3x10^{-7}$ x 50 %** = **<u>$1,5x10^{-7}$</u>**	Planning procedure should include the consideration of en-route weather information relevant to the landing sites	$3x10^{-7}$ x 12 %*** = **<u>$0,36x10^{-7}$</u>**
		Inability to follow the required gliding path and to avoid obstacles		Requirement for a radio-altimeter	

* yearly occurrences of a RVR below 550 m or ceiling below 200 ft in AMS

** A conservative figure related to the rate of a successful emergency landing (without fatalities) of 50 % (compared to the 12 % observed by the JAA) was considered for an emergency landing with an RVR below 550 m and a ceiling below 200 ft on a planned landing site.

*** With the considered mitigation, it is expected that the fatal accident rate in case of an emergency landing is at least comparable to the one observed by the JAA.

<u>Conclusion:</u>

Taking into account the probability of such accident, it is considered that no additional mitigation is necessary.

Scenario 4	**Escalation factor**	**Consequences**	**Risk evaluation**	**JAA NPA OPS 29 Rev 2 Mitigations**	**Residual risk evaluation**
Loss of power ($10x10^{-6}$)	Flight during the night and emergency landing site without any lighting. 50 %* x 93 %** = 46,5 % 10 % of the selected landing sites are not aerodromes and don't have lighting system	Late visual acquisition of the landing site Unstabilised approach Crash with fatalities	$4,65x10^{-6}$ x 50 %*** = **$\underline{2,325x10^{-6}}$**	Landing light capable of illuminating the touchdown point from 200 ft on the power-off glide path.	$4,65x10^{-6}$ x 12 % = **$\underline{0,558x10^{-7}}$**

* It is considered that on a yearly basis 50 % of the flights are operated at night.

** Taking into consideration the number of aerodromes available in Europe, that 70 % of the selected emergency landing site would be aerodrome and 30 % fields.

Out of these 70 %, it is considered that an average of 10 % of them have a runway of at least 3.000 ft, a lighting system available and are open H24. Therefore, the total amount of landing sites with no lighting system is estimated at around 93 %.

*** A conservative figure related to the rate of a successful emergency landing (without fatalities) of 50 % (compared to the 12 % observed by the JAA) was considered for an emergency landing on a landing site without any lighting.

Conclusion:

Taking into account the probability of such event, it is considered that no additional mitigation is necessary.

Scenario 5	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Flight over hostile/congested area within the gliding distance (30 %)*	No landing site available. Crash with fatalities	$3x10^{-6}$ X 0,7 %** = **$2,1x10^{-6}$**	Routing and cruise altitude selected so as to have a landing site within gliding range. Gliding capabilities 15 mn risk period Flight planning	$0,19x10^{-6}$***

* It is considered that due the availability of aerodromes in Europe, the proportion of flights for which no aerodrome and no landing sites would be available is limited to 30 %. This assumption is excluding the take-off and landing phases since the risk would be basically the same for IMC/night and VMC if no landing site is available).

This assumption is based on the operation of a C208, since among the 3 main aeroplane types which are currently considered to meet the NPA OPS 29 Rev 2 requirements, C208 is the one having the lowest operating altitude.

** Estimated probability (70 %) for fatalities in such situation based on a JAA estimation (See JAA NPA OPS 29 Rev 2 RIA)

*** Source JAA NPA OPS 29 AASG10 (Calculation of the contribution to the fatal accident rate of a 15 mn risk period).

<u>Conclusion:</u>

Taking into account the probability of such accident, it is considered that no additional mitigation is necessary.

Scenario 6	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Inexperienced crew in relation with the planning phase (20 %)*	Incorrect flight planning Unability to reach the planned landing site Crash with fatalities	$2x10^{-6}$ x ($0,2 \times 5x10^{-3}$ + $0,8 \times 5x10^{-4}$)** = **$2,8x10^{-9}$**	Minimum experience requirements Routes/areas described in the operations manual Procedure for flight planning	$2x10^{-6}$ x $5x10^{-4}$ = **$1x10^{-9}$**

* The average proportion of flight crew considered to be inexperienced is considered to be around 20 %.

** Human error probability average value considering a rule based behaviour (source journal of engineering and electronics 2009).

Based on the type of behaviour, a human error probability can be derived:

Behaviour mode	HEP
Skill-based	$5x10^{-4}$
Rule-based	$5x10^{-3}$
Knowledge-based	$5x10^{-2}$

<u>Conclusion:</u> Taking into account the probability of such accident, it is considered that no additional mitigation is necessary.

Scenario 7	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Crew without the relevant experience related to the conduct of the emergency landing (20 %)*	The pilot doesn't follow the required procedure Unable to reach the planned landing site Crash with fatalities	$10x10^{-6}$ x (0,2 x 50 % + 0,8 x 12 %)** = **<u>$1,96x10^{-6}$</u>**	Minimum experience requirements to be specified by the operator in the OM.	$1,2 \times 10^{-6}$
		Height over the landing site threshold too high (>35 ft) Unability to stop the aeroplane within the landing site Crash with fatalities		Specific crew training requirement in relation with the conduct of an emergency landing	
		High crew workload not managed by the pilot Unability to follow the required procedures Crash with fatalities			

* The average proportion of flight crew considered not to have the relevant experience is estimated to be around 20 %.

** Considering the overall probability of a fatal accident following an engine failure (12 %), the rate for pilots without the relevant experience has been raised to 50 %.

<u>Conclusion:</u>

Taking into account the probability of such accident, it is considered that no additional mitigation is necessary.

Scenario 8	Escalation factor	Consequences	Risk evaluation	JAA NPA OPS 29 Rev 2 Mitigations	Residual risk evaluation
Loss of power ($10x10^{-6}$)	Loss of all means of attitude information or unannunciated misleading attitude information. (10^{-3} %)*	Disorientation of the flight crew The crew would not have sufficient information to maintain a proper attitude and would likely inadvertently exceed attitude limits, which could result in the loss of control of the aircraft. Unability to reach a landing site/safe forced landing area Crash with fatalities	$1x10^{-8}$ x 12 % = **$0,12 \times 10^{-8}$**	1. Two separate electrical generating systems [..] 2. An emergency electrical supply system [..] 3. 2 attitude indicators powered from independent sources [..]	**$0,12 \times 10^{-11}$**

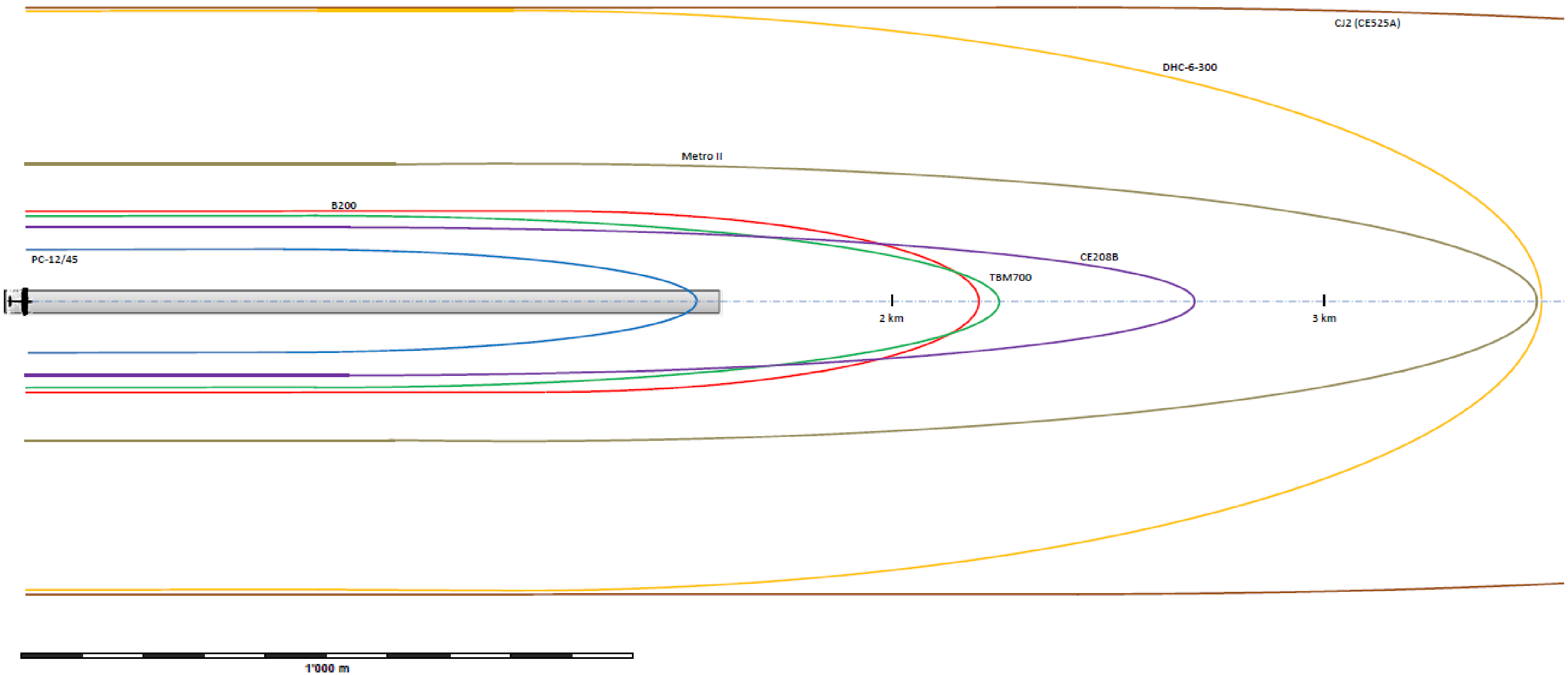
* It is noted that this scenario is intended to provide an example of escalation factor of technical nature. A comprehensive analysis of failure conditions affecting equipment, systems, and installations is required by 23.1309 and relevant guidance material.

According to FAA AC 23.1309-1E 'Loss of all means of attitude information' and 'Misleading and/or Malfunction Without Warning' are Classified Catastrophic. The corresponding Allowable Qualitative Probability for a Class III aircraft is 1.0x10-8 . Hence the assumed probability of 1.0x10-3 is a conservative figure.

Conclusion:

Taking into account the probability of such accident, it is considered that no additional mitigation is necessary.

6.3. Appendix B: Noise footprint at take-off



		Lmax (300m)	Climbgradient	D_{15}	
	B200	77.6 dB(A)	10.3 °	1019 m	
	PC-12/45	73.0 dB(A)	7.9 °	705 m	
	TBM 700	76.9 dB(A)	8.5 °	650 m	PA-46-350P / PA-31-350
	CE208B	75.4 dB(A)	5.0 °	762 m	
	CJ2	88.0 dB(A)	3.1 °	1042 m	
	DHC-6-300	87.8 dB(A)	10.3 °	457 m	
	Metro II	81.6 dB(A)	7.6 °	847 m	BN2B-20 ISLANDER

Figure 2 – Comparison 80dB(A) footprint at Take-Off

6.4. Appendix C: Emission comparison

Figure 3- LTO CO, HC, NOx, CO2

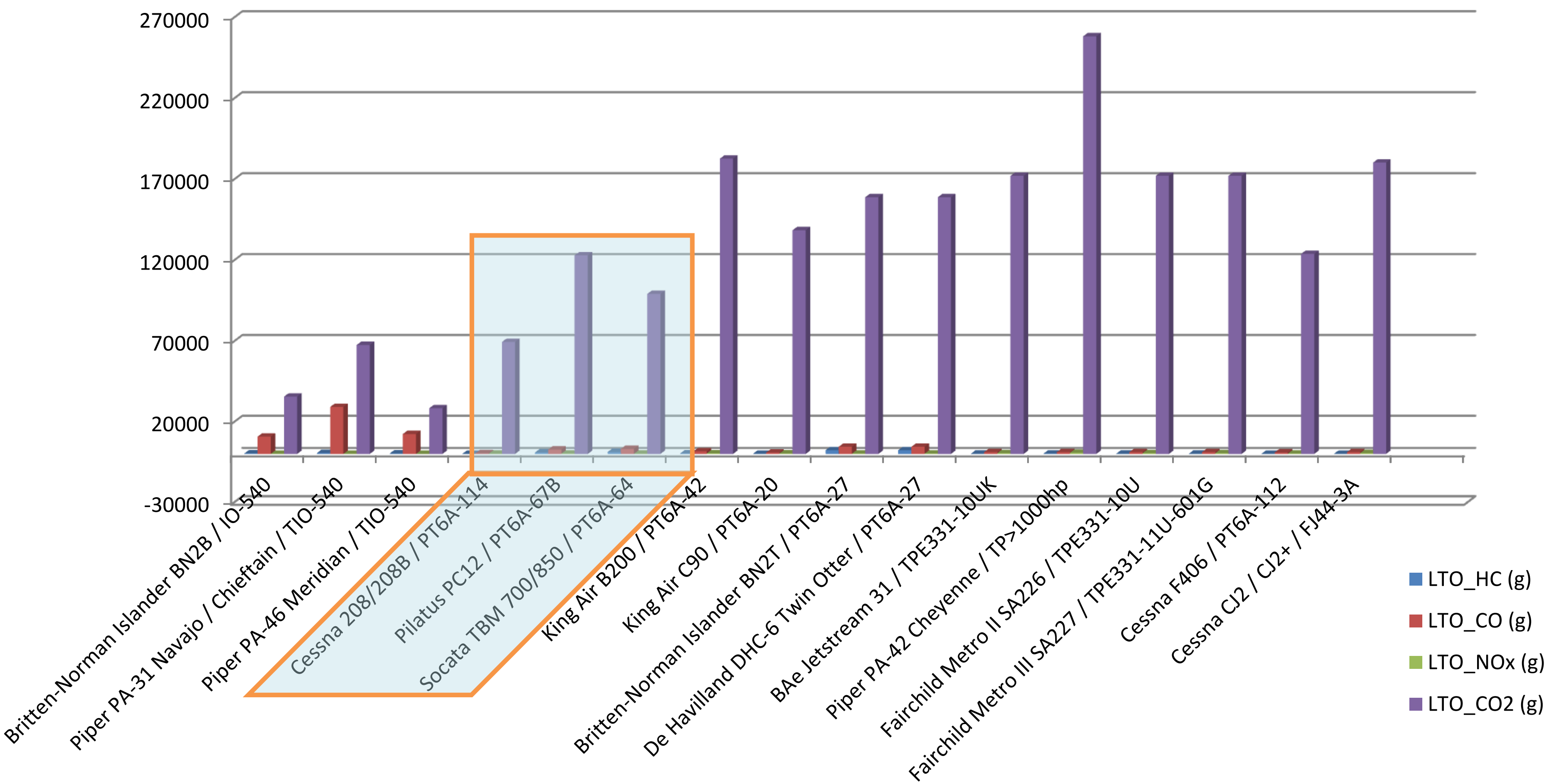


Figure 4- LTO CO, HC, NOx

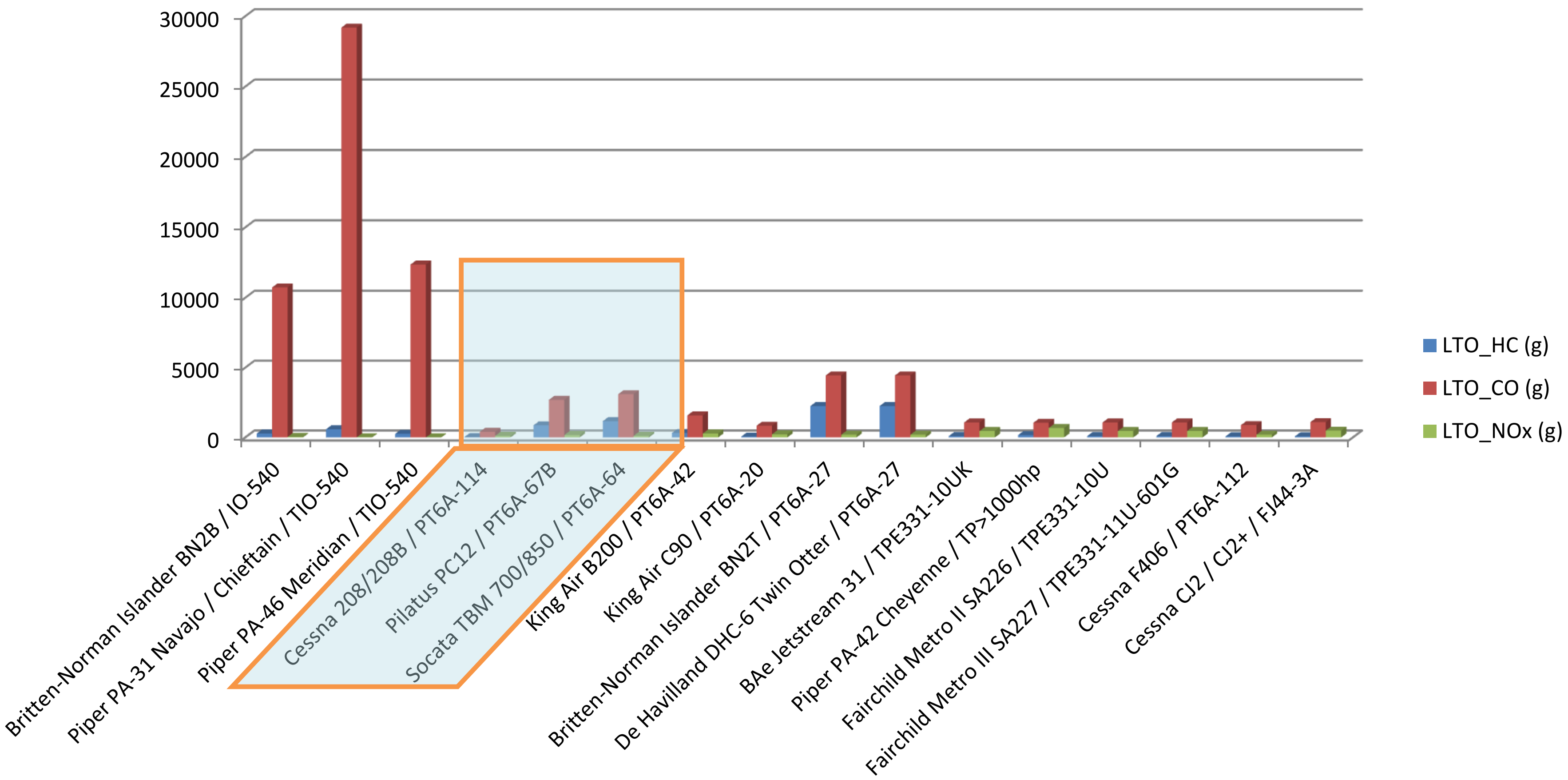
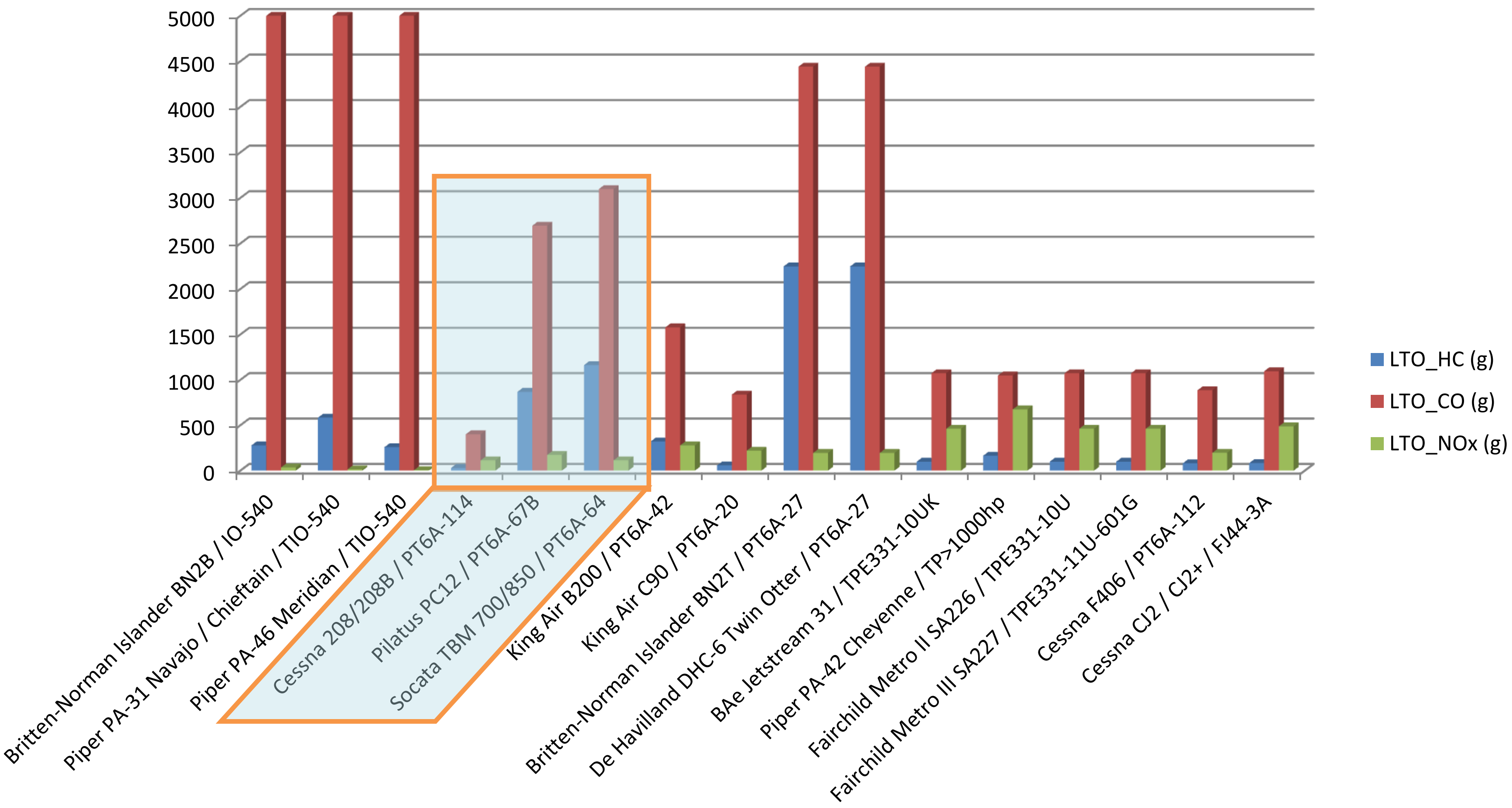


Figure 5- LTO CO, HC, NOx (detail 0-5000 g)



6.5. Appendix D: Operating costs comparison

An analysis of the operating costs of illustrative single-engined and twin-engined turboprop aircraft was performed to support the Regulatory Impact Assessment (RIA) of the current NPA.

To determine the aeroplanes to be compared, the current SET operators have been consulted and the choice has been based on 'mission profiles' drawn from real-life operations and competitive situations, and, therefore, to establish cost comparisons based on the same mileage flown by all aircraft. The column headers of the cost comparisons provided below indicate the type of mission profiles.

For practical reasons and to avoid introducing biases in the cost analysis, it has been decided to use a worldwide known and largely accepted database (Conklin & de Decker[6]). The analysis was conducted based on this database's metrics for economics and performance. The crew composition, however, is based on ORO.FC.200 requirements.

The results do show an actual cost-effective edge in favor of SET aircraft that remains nevertheless in some cases quite marginal. It confirms the fact and experience that an operator's choice for SET aircraft depends on more than the operating costs alone, and for instance takes into consideration :

- modern aircraft design
- technical upgrades availability (e.g. avionics)
- aircraft availability and age
- manufacturer's support
- availability and price of spare parts
- availability of rated pilots and training facilities
- typical or expected ratio between up-time / down-time (e.g. requirement for airframe overhauls or not)
- maintenance schedule
- STOL performance to allow greater airport accessibility
- cabin versatility and comfort
- etc.

[6] Conklin & de Decker is a renown general aviation cost database and cost consulting firm. They define themselves as follows : 'The mission of Conklin & de Decker is to furnish the general aviation industry with objective and impartial information in the form of professionally developed and supported products and services, which enables customers to make more informed decisions when dealing with the purchase and operation of aircraft. ' More details on https://www.conklindd.com/Default.a

Comparison 1: TBM850 operating cost vs typical competitors

Conklin & de Decker
Aviation Information

Aircraft Cost Evaluator
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ESTIMATED VARIABLE COSTS - Per Hour		(Charter)	(Charter)
	TBM 850	**Citation Mustang**	**King Air C90GTi**
Fuel (1)	€291,26	€341,42	€370,36
Fuel Additives	€0,62		
Lubricants			
Maintenance Labor (2)	€63,75	€51,00	€82,45
Parts Airframe/Eng/Avion (3)	€44,55	€44,38	€63,48
Engine Restoration (4)	€115,12	€176,62	€178,40
Thrust Reverser Allowance			
Propeller Allowance	€2,82		€4,47
APU Allowance			
Major Periodic Maintenance			
Misc Exp. - Landing/Parking	€6,24	€7,29	€8,52
- Crew Expenses			
- Supplies/Catering			
- Carbon Offset (5)			
- Other			
Fractional Fuel Surcharge Cost/Hour			
Fractional Cost/Hour			
Total Variable Cost/Hour	**€524,36**	**€620,71**	**€707,68**
Cost per Nautical Mile	€1,86	€2,02	€2,95
Average Speed-Kts. (6) 300-nm trip	282	307	240

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - Size of Operation: 1 - 2 Aircraft **Date:** 25-09-2013 **Currency:** €

Type of Operation:	**Corporate**	**Corporate**	**Corporate**
1. Fuel Cost	0,95	0,95	0,95
Liters/Hour Blk Fuel/Flt Time +15%	307	359	390
2. Maint. Labor Cost per Hour	85	85	85
Maint. Hours/Flight Hours	0,75	0,60	0,97
3. Incl. Engine Parts Cost	No	No	No
Engine Model	PT6A-66D	PW615F	PT6A-135A
Aircraft Model Year	New	New	2010
4. Overhaul Cost Source	JSSI Prem12	JSSI Prem12	JSSI Prem12
5. CO2 Cost Per Tonne			
6. Block Speed Source	Estimated	Estimated	AC Manual

ANNUAL FIXED COSTS		(Charter)	(Charter)
	TBM 850	**Citation Mustang**	**King Air C90GTi**
Crew salaries - Captain (7)	€64.600	€63.840	€66.120
- Co Pilot		€44.688	
- Flt Attendant			
- Flt Eng/Other			
- Benefits	€19.380	€19.152	€32.148
Hangar - Typical	€11.856	€14.288	€14.516
Insurance - Hull (8)	€10.238	€10.427	€10.944
Single Limit Liability	€4.940	€7.600	€4.940
Recurrent Training	€6.460	€19.912	€8.056
Aircraft Modernization (9)	€15.200	€15.200	€22.800
Navigation Chart Service	€924	€2.844	€924
Refurbishing (10)	€8.500	€6.800	€8.500
Computer Mx. Program (11)	€1.824	€2.470	€2.280
Weather Service (12)	€532	€532	€532
Other Fixed Costs			
Mgmt Fee/Yr			
Total Fixed Cost/Year	**€144.454**	**€207.753**	**€171.760**

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - Size of Operation: 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
7. Crew Salary Source	Estimated	12 NBAA	Estimated
Number of Crew	1	2	1
8. Ins Hull Value/Frac Share Cost	2.559.604	2.606.800	1.824.000
Hull Insurance Rate (%)	0,40	0,40	0,60
9. Modernization	10 Yr Avg	10 Yr Avg	10 Yr Avg
10. Refurbish Labor Hrs/Seat	20	20	20
11. Comp. Mx Program Source	Typical	Typical	Typical
12. Weather Service Source	Typical	Typical	Typical

ANNUAL BUDGET		(Charter)	(Charter)
	TBM 850	**Citation Mustang**	**King Air C90GTi**
Utilization - Nt. Miles	115.000	115.000	115.000
- Hours	408	375	479
Variable Cost	€213.939	€232.766	€338.979
Fixed Cost	€144.454	€207.753	€171.760
Total Cost (No Depreciation)	**€358.393**	**€440.519**	**€510.739**
- Per Hour	€878,41	€1.174,72	€1.066,26
- Per Nt. Mile	€3,12	€3,83	€4,44
- Per Seat Nt. Mile	€0,62	€0,96	€0,89
Total Cost (No Depreciation)	€358.393	€440.519	€510.739
Book Depreciation (13)	€255.960	€260.680	€182.400
Total Cost (Book Dep)	**€614.353**	**€701.199**	**€693.139**
- Per Hour	€1.505,77	€1.869,86	€1.447,05
- Per Nt. Mile	€5,34	€6,10	€6,03
- Per Seat Nt. Mile	€1,07	€1,52	€1,21
Total Cost (No Depreciation)	€358.393	€440.519	€510.739
Market Depreciation (14)	€153.576	€104.272	€109.440
Total Cost (Market Dep.)	**€511.969**	**€544.791**	**€620.179**
- Per Hour	€1.254,83	€1.452,78	€1.294,74
- Per Nt. Mile	€4,45	€4,74	€5,39
- Per Seat Nt. Mile	€0,89	€1,18	€1,08

Cost data in this report is intended to be used as a benchmark

Footnotes - Size of Operation: 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
13. Book Depreciation Rate % per Year	10	10	10
14. Market Depreciation Rate % per Year	6	4	6

Comparison 2: PC12 operating cost vs typical competitors

Conklin & de Decker
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ESTIMATED VARIABLE COSTS - Per Hour		(Charter)	(Medevac)
	PC 12 NG	**Citation CJ2+**	**King Air B200GT**
Fuel (1)	€280,47	€603,17	€485,43
Fuel Additives			
Lubricants			
Maintenance Labor (2)	€64,60	€93,50	€82,45
Parts Airframe/Eng/Avion (3)	€59,79	€66,60	€64,29
Engine Restoration (4)	€120,93	€199,85	€189,54
Thrust Reverser Allowance			
Propeller Allowance	€2,78		€5,39
APU Allowance			
Major Periodic Maintenance			
Misc Exp. - Landing/Parking	€8,81	€10,54	€10,54
- Crew Expenses			
- Supplies/Catering			
- Carbon Offset (5)			
- Other			
Fractional Fuel Surcharge Cost/Hour			
Fractional Cost/Hour			
Total Variable Cost/Hour	**€537,38**	**€973,66**	**€837,64**
Cost per Nautical Mile	€2,15	€2,59	€3,10
Average Speed-Kts. (6) 300-nm trip	250	376	270

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - Size of Operation: 1 - 2 Aircraft **Date:** 25-09-2013 **Currency:** €

Type of Operation:	**Corporate**	**Corporate**	**Corporate**
1. Fuel Cost	0,95	0,95	0,95
Liters/Hour Blk Fuel/Flt Time +15%	295	635	511
2. Maint. Labor Cost per Hour	85	85	85
Maint. Hours/Flight Hours	0,76	1,10	0,97
3. Incl. Engine Parts Cost	No	No	No
Engine Model	PT6A-67P	FJ44-3A-24	PT6A-52
Aircraft Model Year	New	New	2013
4. Overhaul Cost Source	JSSI Prem12	TAP Elite 2	JSSI Prem12
5. CO2 Cost Per Tonne			
6. Block Speed Source	AC Manual	Mftr Data	AC Manual

ANNUAL FIXED COSTS		**(Charter)**	**(Medevac)**
	PC 12 NG	**Citation CJ2+**	**King Air B200GT**
Crew salaries - Captain (7)	€64.600	€76.000	€66.880
- Co Pilot		€45.600	
- Flt Attendant			
- Flt Eng/Other			
- Benefits	€19.380	€36.480	€20.064
Hangar - Typical	€20.520	€19.380	€19.532
Insurance - Hull (8)	€13.929	€13.733	€15.200
Single Limit Liability	€4.940	€8.360	€4.940
Recurrent Training	€7.752	€21.584	€9.424
Aircraft Modernization (9)	€15.200	€15.200	€22.800
Navigation Chart Service	€924	€2.844	€924
Refurbishing (10)	€11.900	€15.300	€10.200
Computer Mx. Program (11)	€1.824	€2.470	€2.280
Weather Service (12)	€532	€532	€532
Other Fixed Costs			
Mgmt Fee/Yr			
Total Fixed Cost/Year	**€161.501**	**€257.483**	**€172.776**

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - **Size of Operation:** 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
7. Crew Salary Source	Estimated	12 NBAA	Estimated
Number of Crew	1	2	1
8. Ins Hull Value/Frac Share Cost	3.482.320	5.493.280	3.800.000
Hull Insurance Rate (%)	0,40	0,25	0,40
9. Modernization	10 Yr Avg	10 Yr Avg	10 Yr Avg
10. Refurbish Labor Hrs/Seat	20	30	20
11. Comp. Mx Program Source	Typical	Typical	Typical
12. Weather Service Source	Typical	Typical	Typical

ANNUAL BUDGET		**(Charter)**	**(Medevac)**
	PC 12 NG	**Citation CJ2+**	**King Air B200GT**
Utilization - Nt. Miles	115.000	115.000	115.000
- Hours	460	306	426
Variable Cost	€247.195	€297.940	€356.835
Fixed Cost	€161.501	€257.483	€172.776
Total Cost (No Depreciation)	**€408.696**	**€555.423**	**€529.611**
- Per Hour	€888,47	€1.815,11	€1.243,22
- Per Nt. Mile	€3,55	€4,83	€4,61
- Per Seat Nt. Mile	€0,59	€0,80	€0,77
Total Cost (No Depreciation)	€408.696	€555.423	€529.611
Book Depreciation (13)	€348.232	€549.328	€380.000
Total Cost (Book Dep)	**€756.928**	**€1.104.751**	**€909.611**
- Per Hour	€1.645,50	€3.610,30	€2.135,24
- Per Nt. Mile	€6,58	€9,61	€7,91
- Per Seat Nt. Mile	€1,10	€1,60	€1,32
Total Cost (No Depreciation)	€408.696	€555.423	€529.611
Market Depreciation (14)	€208.939	€219.731	€228.000
Total Cost (Market Dep.)	**€617.635**	**€775.154**	**€757.611**
- Per Hour	€1.342,68	€2.533,18	€1.778,43
- Per Nt. Mile	€5,37	€6,74	€6,59
- Per Seat Nt. Mile	€0,90	€1,12	€1,10

Cost data in this report is intended to be used as a benchmark

Footnotes - Size of Operation: 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
13. Book Depreciation Rate % per Year	10	10	10
14. Market Depreciation Rate % per Year	6	4	6

Comparison 3: C208 operating cost vs typical competitors

Conklin & de Decker
Aviation Information

Aircraft Cost Evaluator
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ESTIMATED VARIABLE COSTS - Per Hour		(Shuttle)	(Cargo)
	208B Gnd Caravan/Carg Pod	**BN2T Turbine Islander**	**Cheyenne IIIA**
Fuel (1)	€235,70	€210,89	€537,57
Fuel Additives	€0,43		
Lubricants			
Maintenance Labor (2)	€46,75	€108,80	€249,90
Parts Airframe/Eng/Avion (3)	€34,43	€47,29	€123,86
Engine Restoration (4)	€79,29	€171,76	€198,68
Thrust Reverser Allowance			
Propeller Allowance	€1,44	€2,59	€4,30
APU Allowance			
Major Periodic Maintenance			
Misc Exp. - Landing/Parking	€7,38	€5,90	€9,45
- Crew Expenses			
- Supplies/Catering			
- Carbon Offset (5)			
- Other			
Fractional Fuel Surcharge Cost/Hour			
Fractional Cost/Hour			
Total Variable Cost/Hour	**€405,42**	**€547,23**	**€1.123,76**
Cost per Nautical Mile	€2,72	€3,72	€3,96
Average Speed-Kts. (6) 200-nm trip	149	147	284

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - Size of Operation: 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
Type of Operation:	**Corporate**	**Corporate**	**Corporate**
1. Fuel Cost	0,95	0,95	0,95
Liters/Hour Blk Fuel/Flt Time +15%	248	222	566
2. Maint. Labor Cost per Hour	85	85	85
Maint. Hours/Flight Hours	0,55	1,28	2,94
3. Incl. Engine Parts Cost	No	No	No
Engine Model	PT6A-114A	250-B17C	PT6A-61
Aircraft Model Year	New	2001	1991
4. Overhaul Cost Source	JSSI Prem12	Estimated	JSSI Prem12
5. CO2 Cost Per Tonne			
6. Block Speed Source	Mftr Data	Estimated	AC Manual

ANNUAL FIXED COSTS		(Shuttle)	(Cargo)
	208B Gnd Caravan/Carg Pod	**BN2T Turbine Islander**	**Cheyenne IIIA**
Crew salaries - Captain (7)	€64.600	€66.120	€66.120
- Co Pilot			
- Flt Attendant			
- Flt Eng/Other			
- Benefits	€19.380	€32.148	€32.148
Hangar - Typical	€17.632	€14.288	€16.872
Insurance - Hull (8)	€10.485	€5.016	€4.902
Single Limit Liability	€4.940	€4.940	€4.940
Recurrent Training	€6.460	€7.600	€7.600
Aircraft Modernization (9)	€15.200	€34.200	€34.200
Navigation Chart Service	€924	€924	€924
Refurbishing (10)	€15.300	€13.600	€10.200
Computer Mx. Program (11)	€1.140	€2.280	€2.280
Weather Service (12)	€532	€532	€532
Other Fixed Costs			
Mgmt Fee/Yr			
Total Fixed Cost/Year	**€156.593**	**€181.648**	**€180.718**

Cost data in this report is intended to be used as a benchmark

FOOTNOTES - **Size of Operation:** 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
7. Crew Salary Source	Estimated	Estimated	Estimated
Number of Crew	1	1	1
8. Ins Hull Value/Frac Share Cost	1.747.525	836.000	817.000
Hull Insurance Rate (%)	0,60	0,60	0,60
9. Modernization	10 Yr Avg	10 Yr Avg	10 Yr Avg
10. Refurbish Labor Hrs/Seat	20	20	20
11. Comp. Mx Program Source	Typical	Typical	Typical
12. Weather Service Source	Typical	Typical	Typical

ANNUAL BUDGET		(Shuttle)	(Cargo)
	208B Gnd Caravan/Carg Pod	**BN2T Turbine Islander**	**Cheyenne IIIA**
Utilization - Nt. Miles	115.000	115.000	115.000
- Hours	774	785	405
Variable Cost	€313.795	€429.576	€455.123
Fixed Cost	€156.593	€181.648	€180.718
Total Cost (No Depreciation)	**€470.388**	**€611.224**	**€635.841**
- Per Hour	€607,74	€778,63	€1.569,98
- Per Nt. Mile	€4,09	€5,31	€5,53
- Per Seat Nt. Mile	€0,45	€0,59	€0,61
Total Cost (No Depreciation)	€470.388	€611.224	€635.841
Book Depreciation (13)	€174.753	€83.600	€81.700
Total Cost (Book Dep)	**€645.141**	**€694.824**	**€717.541**
- Per Hour	€833,52	€885,13	€1.771,71
- Per Nt. Mile	€5,61	€6,04	€6,24
- Per Seat Nt. Mile	€0,62	€0,67	€0,69
Total Cost (No Depreciation)	€470.388	€611.224	€635.841
Market Depreciation (14)	€104.852	€50.160	€49.020
Total Cost (Market Dep.)	**€575.240**	**€661.384**	**€684.861**
- Per Hour	€743,20	€842,53	€1.691,01
- Per Nt. Mile	€5,00	€5,75	€5,96
- Per Seat Nt. Mile	€0,56	€0,64	€0,66

Cost data in this report is intended to be used as a benchmark

Footnotes - Size of Operation: 1 - 2 Aircraft		**Date:** 25-09-2013	**Currency:** €
13. Book Depreciation Rate % per Year	10	10	10
14. Market Depreciation Rate % per Year	6	6	6

6.6. Appendix E: Population density by EU country, US State and Canadian province (2010 and 2011)

	Country / State	Population per Square Mile	Population per Square Kilometer (Sq. Mile x 0.3861)
United States	District of Columbia	9856.5	3805.6
EU	Malta		1318.6
EU	Netherlands		494.5
United States	New Jersey	1195.5	461.6
United States	Rhode Island	1018.1	393.1
EU	Belgium		364.3
United States	Massachusetts	839.4	324.1
United States	Connecticut	738.1	285.0
EU	United Kingdom		256.8
EU	Lichtenstein		232.5
United States	Maryland	594.8	229.7
EU	Germany		229.0
EU	Italy		201.5
EU	Luxembourg		200.4
EU	Switzerland		197.8
United States	Delaware	460.8	177.9
United States	New York	411.2	158.8
EU	Czech Republic		135.9
United States	Florida	350.6	135.4
EU	Denmark		129.7
EU	Poland		123.2
EU	Portugal		114.5

EU	Slovakia		110.1
United States	Pennsylvania	283.9	109.6
United States	Ohio	282.3	109.0
EU	Hungary		107.2
EU	France		103.0
EU	Austria		102.2
EU	Slovenia		101.9
EU	Turkey		95.0
EU	Romania		93.0
United States	California	239.1	92.3
EU	Cyprus		92.3
EU	Spain		92.0
United States	Illinois	231.1	89.2
EU	Greece		86.4
EU	Macedonia		82.6
United States	Hawaii	211.8	81.8
United States	Virginia	202.6	78.2
EU	Croatia		77.8
United States	North Carolina	196.1	75.7
United States	Indiana	181	69.9
EU	Bulgaria		67.5
United States	Michigan	174.8	67.5
EU	Ireland		66.9
United States	Georgia	168.4	65.0
United States	South Carolina	153.9	59.4
United States	Tennessee	153.9	59.4

United States	New Hampshire	147	56.8
EU	Lithuania		48.3
EU	Montenegro		44.9
United States	Kentucky	109.9	42.4
United States	Wisconsin	105	40.5
United States	Louisiana	104.9	40.5
United States	Washington	101.2	39.1
United States	Texas	96.3	37.2
United States	Alabama	94.4	36.4
United States	Missouri	87.1	33.6
EU	Latvia		33.1
EU	Estonia		30.9
United States	West Virginia	77.1	29.8
United States	Vermont	67.9	26.2
United States	Minnesota	66.6	25.7
Canada	Prince Edwards Island		24.7
United States	Mississippi	63.2	24.4
EU	Sweden		23.0
United States	Arizona	56.3	21.7
United States	Arkansas	56	21.6
United States	Oklahoma	54.7	21.1
United States	Iowa	54.5	21.0
United States	Colorado	48.5	18.7
EU	Finland		17.7
Canada	Nova Scotia		17.4

United States	Maine	43.1	16.6
EU	Norway		16.2
United States	Oregon	39.9	15.4
Canada	Ontario		14.1
United States	Kansas	34.9	13.5
United States	Utah	33.6	13.0
Canada	New Brunswick		10.5
United States	Nevada	24.6	9.5
United States	Nebraska	23.8	9.2
United States	Idaho	19	7.3
United States	New Mexico	17	6.6
Canada	Quebec		5.8
Canada	Alberta		5.7
Canada	British Columbia		4.8
United States	South Dakota	10.7	4.1
United States	North Dakota	9.7	3.7
EU	Iceland		3.2
United States	Montana	6.8	2.6
United States	Wyoming	5.8	2.2
Canada	Manitoba		2.2
Canada	Saskatchewan		1.8
Canada	Newfoundland		1.4
United States	Alaska	1.2	0.5
Canada	Yukon		0.1
Canada	Northwest Territories		0.0

Canada	Nunavut		0.0

Sources: Canada (Statistic Canada), Europe (EUROSTAT), and the United States (U.S. Census Bureau)

6.7. Appendix F: QINETIQ recommendation 12.1/9.2.3

This recommendation was related to the assessment of additional equipment requirement in domains which have been identified by QINETIQ as having an impact on the safety of CAT SET-IMC operations.

3.3.1: Power plant and installation

It is considered that most of the contributors mentioned in this paragraph to meet the 10 per million hours in flight shut down or loss of power rate are already covered by existing certification requirements.

Regarding the auto-feathered capability, it is proposed to reject this recommendation since it is deemed that overall it could have a detrimental effect on safety

It is considered that the decision should be left to the pilot rather than having an automatic system since in some cases the engine might continue to deliver some power which could be very helpful to reach a safe forced landing area when the engine failure occurs during the take-off.

Regarding the reversionary engine control mentioned by QinetiQ, the information provided are not considered enough to determine what was the specific intent and, therefore, no specific action is identified.

3.3.2: Fuel system

The proposed measures reflect good design practices and are already covered by the initial airworthiness requirements and by lessons learned from service experience which have been turned into requirements via ADs or in more recent airworthiness requirements.

The fuel system of a SET is relatively simple compared to a twin engine one, hence inherently reducing the chances of confusion, inadvertent operation, misuse. In addition, the system's architecture of a SET (this applies, but is not limited, to the fuel system) is entirely developed around a single source of power and this forces the designer to develop systems robust enough to prevent complete/partial loss of available power.

Finally, it is noted that the proposed measures do apply to each fuel system; hence they should not be exclusively put in relation to CAT SET-IMC.

Therefore, definition of additional prescriptive airworthiness requirements is not deemed required.

It is agreed that some of the topics pointed out by QinetiQ (fuel starvation, proper use of fuel control, displays interpretation, mis-/fueling) contribute to the overall safety of a flight. These items are considered to be already appropriately covered by existing training requirements but only in broad terms.

3.4.1: Electrical

Standby electrical power source. It is considered that requirements defined in Appendix 1 to JAR-OPS 1.247 of the JAA NPA OPS 29 Rev 2 are sufficient although Appendix 1 to JAR-OPS 1.247 does not define a specific duration ('max possible duration of the descent'). It is remarked that the 30 min duration is practically an industry standard and was introduced in the airworthiness requirements at FAR 23 Amdt. 42 (1991).

Moreover, it is noted that for aircraft with type certification basis equal or later than FAR 23 Amdt. 42, airworthiness requirements and GM (FAA AC 25.1353) comprehensively cover these requirements. This GM could be taken into consideration.

Automatic changeover to standby power source: According to FAA AC 23.1309-1E the quantitative requirement for extremely remote is 10E-7. The proposed requirement is for commuter category aircraft, hence considered not proportionate.

Load shedding procedures: Recommendation is supported. However, no further requirement needs to be established since already covered by existing requirements (either in the airworthiness requirements or in NPA OPS 29 Rev 2) and sound design practices.

3.4.2: Flight instruments, warning devices and check-lists

Recommendations are supported. However, no further requirement needs to be established since already covered by existing requirements (either in the airworthiness requirements or in NPA OPS 29 Rev 2) and sound design practices.

3.4.3: Lighting

The general intent of this recommendations is general supported. However, no further requirement needs to be established since already covered by existing requirements (either in the airworthiness requirements or in NPA OPS 29 Rev 2), guidance material, and sound design practices.

Regarding the 1 minute requirement for landing lights, it is not considered to provide any benefit.

3.4.4: Services

Adequate power for 2 attempts at engine re-lighted. This recommendation not supported (see QinetiQ recommendation 12.1/9.2.2 assessment in the RIA section 4.).

Maintain autopilot:

It should be noted that the 3 aeroplane types (TBM700, PC12 and C208), currently considered to be able to meet the NPA OPS 29 Rev 2 equipment requirement, have already the autopilot powered by the emergency power, even if it is not a certification requirement.

Many other aeroplanes types have as well the same functionality.

It is considered that in any case an emergency procedure can be flown without the autopilot with the appropriate training and, therefore, it has been decided not to introduce an additional requirement and to leave some more flexibility.

Undercarriage extension, high lift devices and windscreen wipers: it is considered that NPA OPS-29 requirements are sufficient.

Maximum wheel braking: The assessment of this recommendation would need to be done on a case by case basis taking into consideration the concerned braking system in its entirety. If we take the example of a brake-by-wire system, several systems are already required to maintain the braking function (e.g. anti-skid system, brake control unit computer, etc.). Additionally, such a brake system includes a back-up system that would compensate for loss of electrical power.

As such, it is recommended to reject this recommendation.

3.4.5: Environmental

Power to activate cabin and crew oxygen systems: The recommendation is supported and is considered to be already covered by the requirement on oxygen contained in NPA OPS 29 Rev 2.

Windscreen and airframe de-/anti-icing: This recommendation is rejected (see QinetiQ's recommendation 12.7 assessment in the RIA section 4).

3.4.6: Navigation

NPA OPS 29 Rev 2 requirements related to the systems required to remained powered after an engine loss of power are considered to adequately cover the issue of navigation equipment usability after an engine loss of power.

3.4.7: Demonstration that essential services can be maintained

It is considered that this is adequately addressed by Part 23.1353(h) and their related AMC. No additional requirements are needed. Nonetheless, the general intent of the QinetiQ is supported and, thus, should be addressed by a supporting analysis with support by the TC/STC installer, if necessary.

3.5: Navigation aids

3.5.1 - 3.5.4

It should be noted that such systems don not exist yet and, therefore, these recommendations are proposed to be rejected (see QinetiQ's recommendation 12.1/9.2.1 assessment in the RIA section 4).

Refer also to discussion during the meeting.

3.6: Aircraft handlings

3.6.1 – 3.6.2

Refer to QinetiQ's recommendations 12.5 and 12.8 assessments in the RIA section 4.

3.6.3 – 3.6.4

The existing airworthiness requirements are considered sufficient.

3.7: Airfields facilities

The general intent of these recommendations is supported. Nevertheless, this recommendation has been only partly accepted (Refer to the assessment of QinetiQ's recommendations 12.1/9.1 and 12.2).

3.8: Survivability considerations

3.8.1 - 3.8.2 – 3.8.3

The general intent of the QinetiQ statements are supported. However, it is noted that survivability of a forced landing isn't dependent upon stalling speed only but rather on the energy absorption capability of the aircraft structure.

— Stall speed upper limit (70 Kts): it is difficult to find a convincing argument for a given upper limit since currently there are no data available to justify a stall speed limit.

— The statement '…to allow higher stalling speeds for SET above the maximum 61 Kts currently permitted under CS-23' is incorrect.

CS-23.49 Stalling speed reads:

…

(c) Except as provided in sub-paragraph (d) of this paragraph, VSO at maximum weight must not exceed 113 km/h (61 knots) for –

…

(d) All single-engined aeroplanes, and those twin-engined aeroplanes of 2 722 kg (6 000 lb) or less maximum weight, with a VSO of more than 113 km/h (61 knots) at maximum weight that do not meet the requirements of CS 23.67(a)(1), must comply with CS 23.562(d).

NOTE. 23.562, Emergency landing dynamic conditions

It should also be noted that there are already SET aircraft certified with a stalling speed higher than 61 Kts by means of Special Conditions.

3.8.4

Considering that in any case, the maximum allowable risk period envisaged is 15 mn, this recommendation appears to be disproportionate.

3.8.5

The recommendation is supported. However, no further requirement is needed to be established since it is already covered by existing airworthiness requirements and OPS requirement.

Crew seats: covered by 23.785 Amdt. 23-19 (1977) and CAT.IDE.A.205(a)(3).

Passenger seats: covered by 23.785 Amdt. 23-36 (1988) and CAT.IDE.A.205(a)(5).

According to FAA AC 23-17C Special retroactive requirements, 23.2, is also active.

3.8.6

Recommendation is supported. However, no further requirement is needed to be established since it is already covered by existing airworthiness requirements.

3.8.7

This recommendation is considered to be already covered by OPS requirements (CAT.OP.MPA.170).

6.8. Appendix G: QINETIQ recommendation 12.1/9.2.4 assessment

QinetiQ's recommendation 12.19.2.4:

At the end of (ix) add: 'The emergency electrical supply should have no probable or undetectable failure modes'.

The aim of this assessment is to determine if an existing certification requirement covers this QINETIQ recommendation related to probable/undetectable failure mode of the emergency electrical supply.

23.1309 at Amdt. 23-17 (1977) introduced reliability requirements for equipment, systems, and installations. In the following years, systems performing critical functions were installed in small airplanes and this led to the definition of safety standards for evaluating critical functions that were formally introduced at Amdt. 23-41 (1990). FAA AC 23.1309-1C (1999) and AC 23.1309-1D (2009) provided comprehensive guidance on how to show compliance with 23.1309 and carry out what is currently known as System Safety Analysis and Assessment.

Note: The latest 23.1309 requirement is at Amdt. 23-62 (2012) and the AC is available as 23.1309-1E (2011).

23.1309 at Amdt. 23-17 already considered the need to design equipment, systems, and installations of a single-engined airplane 'to minimize hazards to the airplane in the event of a probable malfunction or failure' but did not specifically address undetectable failure modes. The concept of 'undetected faults' was introduced at Amdt. 23-41.

Nevertheless, the language used in QinetiQ's recommendation is not in line with AMC/GM for 23.1309. The recommendation does not seem to take into consideration the system architecture and results in being prescriptive which may not be the most sound approach. For example, depending on the outcomes of the safety assessment, it could be acceptable to have probable failure modes as long as they are annunciated and the main system is sufficiently reliable (so that the overall safety target is achieved). Conversely, it could be said that a design target should be to avoid probable and undetectable failure modes.

As a result it is suggested to reject QinetiQ's recommendation.

JAA NPA OPS 29 Rev 2 (Appendix 1 to JAR-OPS 1.247) constitutes a good reference to set the requirements for the electrical system. In addition, it could be considered to establish a requirement to assess the total loss of electrical power to be extremely improbable. Expressed in these terms, the requirement is descriptive which allows to adequately consider the system architecture (i.e. number and type of generating systems, number and type of batteries, actual systems' independence). An acceptable means of compliance (AMC) could be a system safety assessment (SSA) of the electrical system supplemented by service experience data.

It is worth noting that an aircraft certified to 23.1309 at Amdt. 23-41 (or higher) would automatically be compliant with this requirement.

6.9. Appendix H: QINETIQ recommendation 12.7 assessment

QinetiQ's recommendation 12.7:

'To allow flight in icing conditions, the applicant must show that anti icing or de-icing of the airframe and transparencies can be maintained with the engine inoperative for the time needed for a descent from the maximum cruising altitude.'

The aim of this assessment is to determine if an existing certification requirement covers this recommendation related to de/anti-icing operation following an engine failure.

For this purpose , it is considered that the overall objective should be to make sure that failure conditions do not prevent continued safe flight and landing. In this respect, although the certification in icing conditions is achieved by showing compliance with a relatively large set of requirements, the analysis can purposely be limited to the following airworthiness requirements:

— 23.1419 Ice protection and the associated AC 23.1419-2() provide requirements (but not all requirements) and the guidance material to achieve the certification in icing conditions.

— 23.1309 and associated AC 23.1309-1() provide requirements and the guidance material on how to carry out a system safety assessment which includes a failure analysis.

— 23.1351 and 23.1353 provide requirements (but not all requirements) relevant to the aircraft electrical system.

— 23.1323 Airspeed indicating system and 23.1325 Static pressure system provide specific requirements relevant to certification for instrument flight rules or flight in icing conditions.

— 23.775 Windshields and windows provides requirements to ensure that when flying in icing conditions the pilot has adequate view to control the aircraft.

Substantiation of the hazard classification of ice protection system failure conditions is typically accomplished through analyses used to identify possible failure conditions and examine their effects on the airplane and its occupants. Example of failure conditions include those allowing an ice shape to accrete in size greater than design levels, asymmetric accretions, accretion in area deemed to be protected. The main objective of these analyses is to show that there is no hazard to the airplane in the event of any power source failure (electrical, bleed air, and pneumatic sources are normally used) during flight in icing conditions. In addition, for single-engined airplanes, the ice protection system must be designed to minimize hazards to the airplane in the event of a probable malfunction or failure.

Furthermore, analysing the certification in icing conditions requires an extensive test program. Complete loss of the airframe IPS is usually considered major and the severity validated with simulated failure ice shapes. Procedures for safe exit and landing are also developed during flight testing. Without going into details, and depending on the applicable certification basis, the flight test program includes flights with failures ice shapes (including total wing and empennage zone failure, pilot's windshield ice protection failure) and verification of emergency and abnormal operating conditions (including determination of the best glide speed in case the IPS becomes inoperative with engine out). The intent of these tests is to verify that the airplane handling qualities have not deteriorated to the extent that the AFM procedures for the condition are ineffective, that AFM procedures and recommended airspeeds are safe, and that the airplane can be landed safely.

In terms of 23.1419 requirement, an important difference exists between aircraft certified before/after Amdt. 23-43. This amendment defined 'capable of operating safely' as follows: the airplane performance, controllability, manoeuvrability, and stability may be degraded from the non-iced airplane but must not be less than the requirements in Part 23, subpart B.

Compliance with subpart B requirements was also required before Amdt. 23-43 although 'capable of operating safely', was not defined in the regulation (at Amendment 23-14). Nevertheless, service experience has shown that aircraft certified in icing conditions prior to the adoption of Amdt. 23-43 have achieved an acceptable level of safety. This is possibly due to the fact that some aircraft were certificated for flight in icing using 25.1419 or the applicants elected to comply to a standard higher than that defined in the regulation. Moreover, in-service issues have been resolved through the continued airworthiness process.

QinetiQ's recommendation is expressed in a broad fashion. It is for example not clear what is meant by 'can be maintained' (the whole IPS system? without any IPS performance degradations?) or by 'with the engine inoperative' (engine power lost, but other power sources may still be available).

In terms of feasibility it is fair to say that for airframe ice protection, no single engine pneumatic boot equipped airplane could meet the proposed requirement - the system either uses engine bleed air or an engine driven air pump – with the possible exception of a fluid system.

The certification in icing conditions of several aircraft has shown that continued safe flight and landing does not necessarily rely on having a fully operational IPS, rather on demonstrating that the aircraft handling qualities satisfy subpart B requirements and that sufficient energy is available to supply the systems necessary to carry out the relevant emergency procedures and ensure a safe landing. The need for electrical power can be different from aircraft to aircraft; however, in many cases, it can be summarised as the electrical power for air data probes (airspeed information, stall warning) and to ensure that the pilot is able to see the landing site (windshield de-mist/fog/ice system).

Therefore, it is recommended to reject QinetiQ's recommendation since service experience demonstrates that the airworthiness requirements and guidance material for certification in icing conditions at system and aircraft level (including requirements for the electrical system) provide for a sufficient level of safety.

For aircraft certified according to Amdt. 23-43 a robust approach is available.

For aircraft certified before Amdt. 23-43, the following baseline is considered to provide for a sufficient level of safety:

1. Initial certification in icing conditions (say Amdt. 23-14) with all relevant Limitations contained in the AFM/POH;

2. No unresolved icing related service history problems;

3. Demonstration that sufficient electrical power is available for the air data probes and, if appropriate, to ensure that the pilot has adequate visibility for the landing.

It is remarked that the requirements contained in JAR NPA OPS 29 Rev 2 (Appendix 1 to JAR-OPS 1.247) provide for a supplementary layer of protection.

Finally, service experience shows that crew proficiency in the use of AFM procedures applicable to flight in conditions conducive to icing and in icing conditions effectively contributes to safe operation. It should be noted that training on operational procedures and requirement for ground de-icing/anti-icing is considered to be already covered by ORO.FC requirements within the recurrent training and checking programme, but only in broad terms.

6.10. Appendix I: ICAO Annex 6 cross-reference table

For each of the ICAO Annex SARPs, the reference to the corresponding material in the proposed text is provided in the second column of the table.

Whenever the proposed text is considered to be less stringent than the ICAO SARPs, rationales are given below it.

ICAO Annex 6 Part I provisions for CAT SE-IMC	EASA NPA
5.4.1 In approving operations by single-engine turbine-powered aeroplanes at night and/or in IMC, the State of the Operator shall ensure that the airworthiness certification of the aeroplane is appropriate and that the overall level of safety intended by the provisions of Annexes 6 and 8 is provided by:	SPA.SET-IMC.105
a) the reliability of the turbine engine;	SPA.SET-IMC.105 paragraph (a)
b) the operator's maintenance procedures, operating practices, flight dispatch procedures and crew training programmes; and	SPA.SET-IMC.105 paragraph (b)
c) equipment and other requirements provided in accordance with Appendix 3.	SPA.SET-IMC.110
5.4.2 All single-engine turbine-powered aeroplanes operated at night and/or in IMC shall have an engine trend monitoring system, and those aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2005 shall have an automatic trend monitoring system.	AMC1 SPA.SET-IMC.105(b) paragraph (a)
Appendix 3	
1.1 Turbine engine reliability shall be shown to have a power loss rate of less than 1 per 100 000 engine hours. *Note.— Power loss in this context is defined as any loss of power, 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. (See Attachment H.)*	AMC1 SPA.SET-IMC.105(a) paragraph (b)
1.2 The operator shall be responsible for engine trend monitoring.	AMC1 SPA.SET-IMC.105(b) paragraph (a)
1.3 To minimize the probability of in-flight engine failure, the engine shall be equipped with:	
a) an ignition system that activates automatically, or is capable of being operated manually, for take-off and landing, and during flight, in visible moisture;	SPA.SET-IMC.110 paragraph (j)

b) a magnetic particle detection or equivalent system that monitors the engine, accessories gearbox, and reduction gearbox, and which includes a flight deck caution indication; and	SPA.SET-IMC.110 paragraph (k)
c) an emergency engine power control device that permits continuing operation of the engine through a sufficient power range to safely complete the flight in the event of any reasonably probable failure of the fuel control unit.	SPA.SET-IMC.110 paragraph (l)
2. Systems and equipment Single-engine turbine-powered aeroplanes approved to operate at night and/or in IMC shall be equipped with the following systems and equipment intended to ensure continued safe flight and to assist in achieving a safe forced landing after an engine failure, under all allowable operating conditions:	
a) two separate electrical generating systems, each one capable of supplying all probable combinations of continuous in-flight electrical loads for instruments, equipment and systems required at night and/or in IMC;	SPA.SET-IMC.110 paragraph (a)
b) a radio altimeter;	SPA.SET-IMC.110 paragraph (g)
c) an emergency electrical supply system of sufficient capacity and endurance, following loss of all generated power, to as a minimum:	SPA.SET-IMC.110 paragraph (i)
1) maintain the operation of all essential flight instruments, communication and navigation systems during a descent from the maximum certificated altitude in a glide configuration to the completion of a landing;	SPA.SET-IMC.110 paragraph (i)(1)
2) lower the flaps and landing gear, if applicable;	SPA.SET-IMC.110 paragraph (i)(3)
3) provide power to one pitot heater, which must serve an air speed indicator clearly visible to the pilot;	SPA.SET-IMC.110 paragraph (i)(6)
4) provide for operation of the landing light specified in 2 j);	SPA.SET-IMC.110 paragraph (i)(5)
5) provide for one engine restart, if applicable; and	SPA.SET-IMC.110 paragraph (i)(2)
6) provide for the operation of the radio altimeter;	SPA.SET-IMC.110

	paragraph (i)(4)
d) two attitude indicators, powered from independent sources;	SPA SET-IMC.110 paragraph (b)
e) a means to provide for at least one attempt at engine re-start;	SPA.SET-IMC.110 paragraph (i)(2)
f) airborne weather radar;	SPA.SET-IMC.110 paragraph (d)
g) a certified area navigation system capable of being programmed with the positions of aerodromes and safe forced landing areas, and providing instantly available track and distance information to those locations;	SPA.SET-IMC.110 paragraph (f)
h) for passenger operations, passenger seats and mounts which meet dynamically-tested performance standards and which are fitted with a shoulder harness or a safety belt with a diagonal shoulder strap for each passenger seat;	SPA.SET-IMC.110 paragraph (c)
i) in pressurized aeroplanes, sufficient supplemental oxygen for all occupants for descent following engine failure at the maximum glide performance from the maximum certificated altitude to an altitude at which supplemental oxygen is no longer required;	SPA.SET-IMC.110 paragraph (e)
j) a landing light that is independent of the landing gear and is capable of adequately illuminating the touchdown area in a night forced landing; and	SPA.SET-IMC.110 paragraph (h)
k) an engine fire warning system.	Not required since, as stated in CS 23.1203, single-engined aeroplanes with the engine in front of the pilot allow the pilot to immediately detect the engine fire.
3. Minimum equipment list The State of the Operator shall require the minimum equipment list of an operator approved in accordance with Chapter 5, 5.4 to specify the operating equipment required for night and/or IMC operations, and for day/VMC operations.	SPA.SET-IMC.105 paragraph (d)(1)
4. Flight manual information The flight manual shall include limitations, procedures, approval status and other information relevant to operations by single-engine turbine-powered aeroplanes at night and/or in	Covered by certification requirements:

IMC.	CS23.1501 CS23.1525 CS23.1581 CS23.1583 CS23.1585
5. Event reporting 5.1 An operator approved for operations by single-engine turbine-powered aeroplanes at night and/or in IMC shall report all significant failures, malfunctions or defects to the State of the Operator who in turn will notify the State of Design.	ORO.GEN.160 + AMC1 ORO.GEN.160 paragraph (c)
5.2 The State of the Operator shall review the safety data and monitor the reliability information so as to be able to take any actions necessary to ensure that the intended safety level is achieved. The State of the Operator will notify major events or trends of particular concern to the appropriate Type Certificate Holder and the State of Design.	AMC3 ARO.OPS.200 paragraph (a)
6. Operator planning 6.1 Operator route planning shall take account of all relevant information in the assessment of intended routes or areas of operations, including the following:	SPA.SET-IMC.105 paragraph (d)
a) the nature of the terrain to be overflown, including the potential for carrying out a safe forced landing in the event of an engine failure or major malfunction;	AMC1 SPA.SET-IMC.105(d)(2)
b) weather information, including seasonal and other adverse meteorological influences that may affect the flight; and	AMC1 SPA.SET-IMC.105(d)(2)
c) other criteria and limitations as specified by the State of the Operator.	AMC1 SPA.SET-IMC.105(d)(2)
6.2 An operator shall identify aerodromes or safe forced landing areas available for use in the event of engine failure, and the position of these shall be programmed into the area navigation system. *Note 1.— A 'safe' forced landing in this context means a landing in an area at which it can reasonably be expected that it will not lead to serious injury or loss of life, even though the aeroplane may incur extensive damage.* *Note 2.— Operation over routes and in weather conditions that permit a safe forced landing in the event of an engine failure, as specified in Chapter 5, 5.1.2, is not required by Appendix 3, 6.1 and 6.2 for aeroplanes approved in accordance with Chapter 5, 5.4. The availability of forced landing areas at all points along a route is not specified for these aeroplanes because of the very high engine reliability, additional systems*	AMC1 SPA.SET-IMC.105(d)(2) AMC2 SPA.SET-IMC.105(d)(2)

and operational equipment, procedures and training requirements specified in this Appendix.	
7. Flight crew experience, training and checking	
7.1 The State of the Operator shall prescribe the minimum flight crew experience required for night/IMC operations by single-engine turbine-powered aeroplanes.	ORO.FC.202 and SPA.SET-IMC.105 paragraph (d)(3)
7.2 An operator’s flight crew training and checking shall be appropriate to night and/or IMC operations by single-engine turbine-powered aeroplanes, covering normal, abnormal and emergency procedures and, in particular, engine failure, including descent to a forced landing in night and/or in IMC conditions.	SPA.SET-IMC.105 paragraph (c)
8. Route limitations over water The State of the Operator shall apply route limitation criteria for single-engine turbine-powered aeroplanes operating at night and/or in IMC on over water operations if beyond gliding distance from an area suitable for a safe forced landing/ditching having regard to the characteristics of the aeroplane, seasonal weather influences, including likely sea state and temperature, and the availability of search and rescue services.	SPA.SET-IMC.105 AMC1 SPA.SET-IMC.105(c)
9. Operator certification or validation The operator shall demonstrate the ability to conduct operations by single-engine turbine-powered aeroplanes at night and/or in IMC through a certification and approval process specified by the State of the Operator.	SPA.SET-IMC.100 SPA.SET-IMC.105 ARO.OPS.200
Note.— Guidance on the airworthiness and operational requirements is contained in Attachment H.	
ATTACHMENT H. ADDITIONAL GUIDANCE FOR APPROVED OPERATIONS BY SINGLE-ENGINE TURBINE-POWERED AEROPLANES AT NIGHT AND/OR IN INSTRUMENT METEOROLOGICAL CONDITIONS (IMC) *Supplementary to Chapter 5, 5.4 and Appendix 3*	
1. Purpose and scope The purpose of this attachment is to give additional guidance on the airworthiness and operational requirements described in Chapter 5, 5.4 and Appendix 3, which have been designed to meet the overall level of safety intended for approved operations by single-engine turbine-powered aeroplanes at night and/or in IMC.	
2. Turbine engine reliability 2.1 The power loss rate required in Chapter 5, 5.4.1 and Appendix 3 should be established as likely to be met based on	AMC1 SPA.SET-IMC.105(a) paragraph (c)

data from commercial operations supplemented by available data from private operations in similar theatres of operation. A minimum amount of service experience is needed on which to base the judgment, and this should include at least 20 000 hours on the actual aeroplane/engine combination unless additional testing has been carried out or experience on sufficiently similar variants of the engine is available.	
2.2 In assessing turbine engine reliability, evidence should be derived from a world fleet database covering as large a sample as possible of operations considered to be representative, compiled by the manufacturers and reviewed with the States of Design and of the Operator. Since flight hour reporting is not mandatory for many types of operators, appropriate statistical estimates may be used to develop the engine reliability data. Data for individual operators approved for these operations including trend monitoring and event reports should also be monitored and reviewed by the State of the Operator to ensure that there is no indication that the operator's experience is unsatisfactory.	AMC1 SPA.SET-IMC.105(a) paragraph (c)
2.2.1 Engine trend monitoring should include the following: a) an oil consumption monitoring programme based on manufacturers' recommendations; and	AMC1 SPA.SET-IMC.105(b) paragraph (a)
b) an engine condition monitoring programme describing the parameters to be monitored, the method of data collection and the corrective action process; this should be based on the manufacturer's recommendations. The monitoring is intended to detect turbine engine deterioration at an early stage to allow for corrective action before safe operation is affected.	AMC1 SPA.SET-IMC.105(b) paragraph (a)
2.2.2 A reliability programme should be established covering the engine and associated systems. The engine programme should include engine hours flown in the period and the in-flight shutdown rate for all causes and the unscheduled engine removal rate, both on a 12-month moving average basis. The event reporting process should cover all items relevant to the ability to operate safely at night and/or in IMC. The data should be available for use by the operator, the Type Certificate Holder and the State so as to establish that the intended reliability levels are being achieved. Any sustained adverse trend should result in an immediate evaluation by the operator in consultation with the State and manufacturer with a view to determining actions to restore the intended safety level. The operator should develop a parts control programme with support from the manufacturer that ensures that the proper parts and configuration are maintained for single-engine turbine-powered aeroplanes approved to conduct these operations. The programme includes verification that parts	AMC1 SPA.SET-IMC.105(b) paragraph (b)

placed on an approved single-engine turbine-powered aeroplane during parts borrowing or pooling arrangements, as well as those parts used after repair or overhaul, maintain the necessary configuration of that aeroplane for operations approved in accordance with Chapter 5, 5.4.	
2.3 Power loss rate should be determined as a moving average over a specified period (e.g. a 12-month moving average if the sample is large). Power loss rate, rather than in-flight shut-down rate, has been used as it is considered to be more appropriate for a single-engine aeroplane. If a failure occurs on a multi-engine aeroplane that causes a major, but not total, loss of power on one engine, it is likely that the engine will be shut down as positive engine-out performance is still available, whereas on a single-engine aeroplane it may well be decided to make use of the residual power to stretch the glide distance.	AMC1 SPA.SET-IMC.105(b)
2.4 The actual period selected should reflect the global utilization and the relevance of the experience included (e.g. early data may not be relevant due to subsequent mandatory modifications which affected the power loss rate). After the introduction of a new engine variant and whilst global utilization is relatively low, the total available experience may have to be used to try to achieve a statistically meaningful average.	AMC1 SPA.SET-IMC.105(b) paragraph (b)
3. Operations manual The operations manual should include all necessary information relevant to operations by single-engine turbine-powered aeroplanes at night and/or in IMC. This should include all of the additional equipment, procedures and training required for such operations, route and/or area of operation and aerodrome information (including planning and operating minima).	AMC3 ORO.MLR.100 paragraphs A.8.1.13, A.9, C.2 and D
4. Operator certification or validation The certification or validation process specified by the State of the Operator should ensure the adequacy of the operator's procedures for normal, abnormal and emergency operations, including actions following engine, systems or equipment failures. In addition to the normal requirements for operator certification or validation, the following items should be addressed in relation to operations by single-engine turbine-powered aeroplanes:	SPA.SET-IMC.100 SPA.SET-IMC.105
a) proof of the achieved engine reliability of the aeroplane engine combination (see Appendix 3, paragraph 1);	SPA.SET-IMC.105 paragraph (a)
b) specific and appropriate training and checking procedures including those to cover engine	SPA.SET-IMC.105 paragraph (c)

failure/malfunction on the ground, after take-off and en-route and descend to a forced landing from the normal cruising altitude;	
c) a maintenance programme which is extended to address the equipment and systems referred to in Appendix 3, paragraph 2;	SPA.SET-IMC.105 paragraph (b)
d) an MEL modified to address the equipment and systems necessary for operations at night and/or in IMC;	SPA.SET-IMC.105 paragraph (d)
e) planning and operating minima appropriate to the operations at night and/or in IMC;	SPA.SET-IMC.105 paragraph (d)(2) CAT.OP.MPA.110 + AMCs
f) departure and arrival procedures and any route limitations;	AMC1 SPA.SET-IMC.105(d)(2) AMC3 SPA.SET-IMC.105(d)(2)
g) pilot qualifications and experience; and	ORO.FC.202 and SPA.SET-IMC.105 paragraph (d)(3)
h) the operations manual, including limitations, emergency procedures, approved routes or areas of operation, the MEL and normal procedures related to the equipment referred to in Appendix 3, paragraph 2.	AMC3 ORO.MLR.100 paragraphs A.8.1.13, A.9, C.2 and D
5. Operational and maintenance programme requirements	
5.1 Approval to undertake operations by single-engine turbine-powered aeroplanes at night and/or in IMC specified in an air operator certificate or equivalent document should include the particular airframe/engine combinations, including the current type design standard for such operations, the specific aeroplanes approved, and the areas or routes of such operations.	ARO.OPS.200 AMC3 ARO.OPS.200 paragraph (c)
5.2 The operator's maintenance control manual should include a statement of certification of the additional equipment required, and of the maintenance and reliability programme for such equipment, including the engine.	Part-M, Appendix V to AMC M.A.704
6. Route limitations over water	
6.1 Operators of single-engine turbine-powered aeroplanes carrying out operations at night and/or in IMC should make an	AMC1 SPA.SET-IMC.105(d)(2)

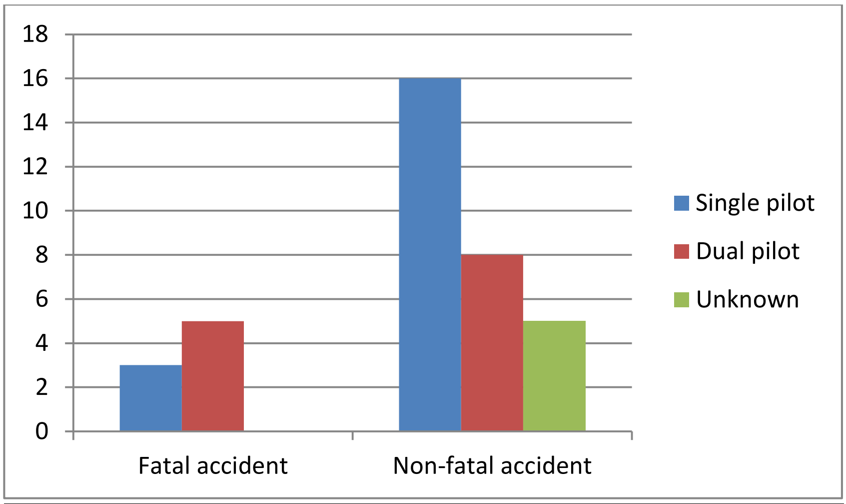
assessment of route limitations over water. The distance that the aeroplane may be operated from a land mass suitable for a safe forced landing should be determined. This equates to the glide distance from the cruise altitude to the safe forced landing area following engine failure, assuming still air conditions. States may add to this an additional distance taking into account the likely prevailing conditions and type of operation. This should take into account the likely sea conditions, the survival equipment carried, the achieved engine reliability and the search and rescue services available.	paragraph (b)
6.2 Any additional distance allowed beyond the glide distance should not exceed a distance equivalent to 15 minutes at the aeroplane's normal cruise speed.	AMC1 SPA.SET-IMC.105(d)(2) paragraph (b)

6.11. Appendix J: Crew composition study in relation with the PWC accident database:

The PWC accident database (for comparable aeroplanes with PWC engine fitted and with engine involvement in the accident) has been reviewed to determine if the number of crew is correlated to the number of fatal accidents.

The following figure provides a graphical representation of the fatal and non-fatal accidents recorded with either one pilot, a second pilot or in some cases with no indication received by PWC on the number of crew.

Figure 6: Number of accidents based on crew composition



It should be noted that, first of all, there is clearly no indication that a second pilot provides any safety benefit in case of an engine failure. Only a few fatal accidents occurred with a single pilot and the reports are showing that.

Regarding the 3 fatal accidents with only one pilot, the following factors have been identified as a contributing factor to the accidents:

- Accident 1: Aircraft located over mountainous terrain, lack of equipment enabling the pilot to locate and identify high terrain, and the resultant manoeuvring required to avoid entering instrument flight conditions prevented the pilot from attempting to glide to the nearest airfield.
- Accident 2: Windshield was contaminated with oil. In addition, no safe forced landing area had been identified before the flight in case of a loss of power.
- Accident 3: Poor safety culture within the operator, poor training programme, tall trees located close to the airstrip and no specific flight planning since the routing had been changed at the last minute.

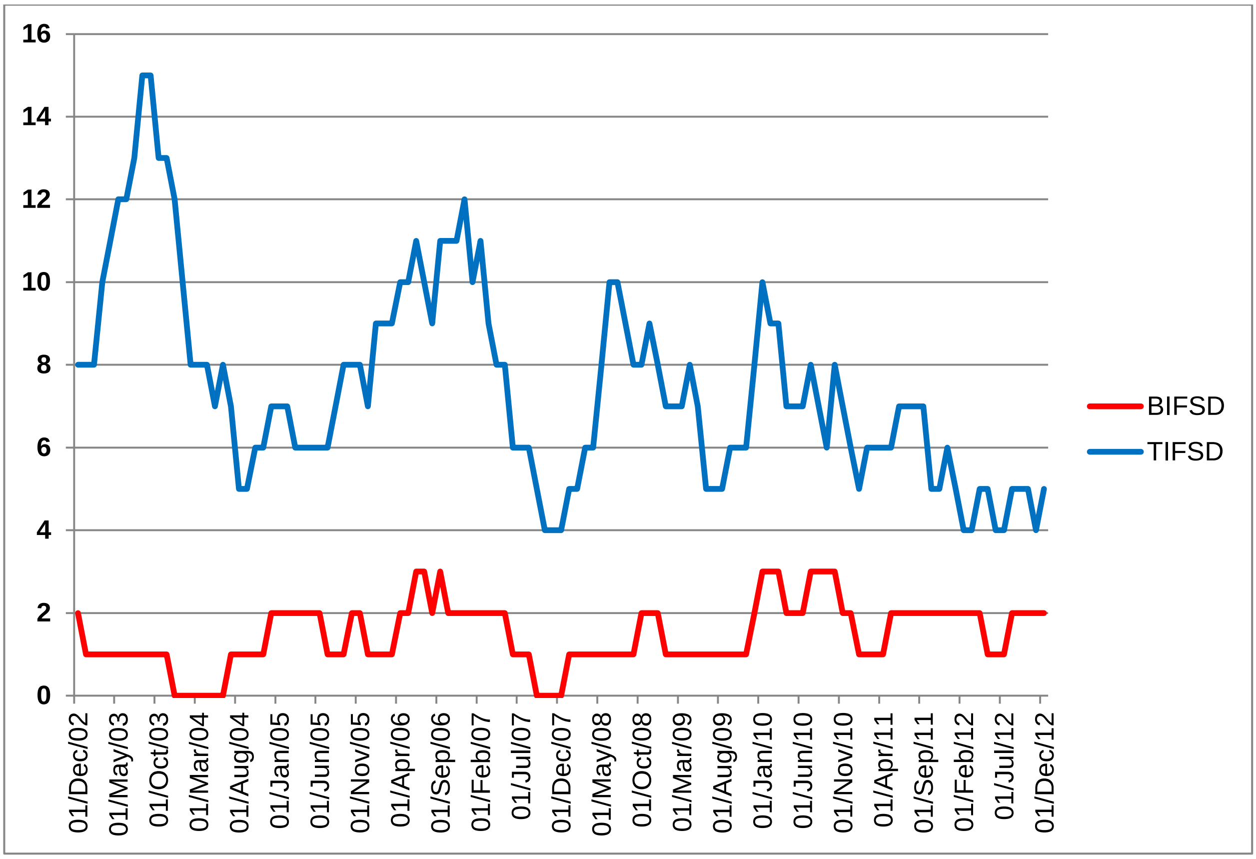
It should be noted that in these 3 specific cases, the mitigations provided by NPA OPS 29 Rev 2 would have considerably helped in reducing the probability of having fatalities. In addition, taking into account the contributing factors identified above during the investigations, there is no indication that a second pilot would have avoided having fatalities.

6.12. Appendix K: PWC engine reliability rate:

This figure is taking into account all PWC turboprop engines fitted on single-engined aeroplane, but excluding agricultural and trainer aeroplanes, and operated worldwide.

The total hours recoded is above 20 million and the annual flight hours of the selected fleet is around 1,8 million.

Figure 7: PWC engine fitted on single-engined aeroplanes total IFSD rate and basic IFSD rate per million flight hours.



TIFSD: total IFSD including all cases where the cause of the engine shut-down has been identified as not being related to the design of the engine. It, therefore, also includes all operational causes (fuel shortage, crew error, …).

BIFSD: All IFSD where the cause of the shut-down is related to the design of the engine.