European Aviation Safety Agency

Opinion No 06/2015

CAT operations at night or in IMC using single-engined turbine aeroplanes

RELATED NPA/CRD 2014-18 — RMT.0232 & RMT.0233 (MDM.031(A)&(B)) — 11.11.2015

EXECUTIVE SUMMARY

This Opinion addresses the following:

— a level playing field issue as some European Air Operator Certificate (AOC) holders are currently authorised to conduct Commercial Air Transport operations using Single-Engined Turbine (SET) aeroplanes in Instrument Meteorological Conditions (IMC) (CAT SET-IMC operations) under exemptions that contain conditions differing from one country to another;

— a regulatory-coordination issue as CAT SET-IMC operations are already allowed by most of the major regulators outside Europe (Federal Aviation Administration (FAA), Transport Canada Civil Aviation (TCCA), Civil Aviation Safety Authority (CASA)), and as the International Civil Aviation Organization (ICAO) already has adopted rules allowing such operations since 10 years;

— an environmental issue as the current regulatory status does not promote the use of modern aeroplanes having a better environmental footprint; and

— an economic and social issue as the current situation prevents the opening of low-density routes with the most appropriate aeroplanes and, therefore, reduces the possibility of movement of the population living in remote areas.

The specific objective is to allow single-engined turbine aeroplanes, meeting specified power plant reliability, equipment, operating, and maintenance requirements, to conduct CAT SET-IMC operations.

This Opinion proposes to introduce a new Subpart L into Annex V (Part-SPA) to Regulation (EU) No 965/2012, containing specific requirements associated with a specific approval for CAT SET-IMC operations in the area of aeroplane equipment, flight planning, flight procedures and crew training. In addition, it introduces consequential amendments to the Cover Regulation, as well as in Annex II (Part-ARO), Annex III (Part-ORO), and Annex IV (Part-CAT) as CAT SET-IMC operations were previously forbidden.

The proposed changes are expected to maintain the safety of CAT operations by allowing, based on proportionate requirements, the operations in IMC and/or at night of single-engined turbine aeroplanes better equipped and with a higher engine reliability than some currently operated twins.

Applicability	
Affected regulations and decisions:	Regulation (EU)No 965/2012; Annex II (Part-ARO); Annex III (Part-ORO); Annex IV (Part-CAT); Annex V (Part-SPA); and related AMC/GM.
Affected stakeholders:	Operators; National Aviation Authorities (NAAs).
Driver/origin:	Level playing field
Reference:	JAA NPA OPS 29 Revision 2; QINETIQ/EMEA/IX/CR0800029/2; ICAO Annex 6, Part I.

Process map	
Terms of Reference (ToR) Issue 2	2.10.2013
Concept Paper:	No
Rulemaking group:	Yes
RIA type:	Full
Technical consultation during NPA drafting:	No
Publication date of the NPA:	17.7.2014
Duration of NPA consultation:	3 months
Review group:	Yes
Focused consultation:	Yes
Publication date of the Decision:	2016/Q3

Table of contents

1. Procedural information 3
1.1. The rule development procedure 3
1.2. The structure of this Opinion and related documents 3
1.3. The next steps in the procedure 3
2. Explanatory Note 5
2.1. Issues to be addressed 5
2.2. Objectives 5
2.3. Outcome of the consultation 5
2.4. Summary of the Regulatory Impact Assessment (RIA) 6
2.5. Overview of the proposed amendments 7
3. References 9
3.1. Affected regulations 9
3.2. Affected decisions 9
3.3. Reference documents 9
4. Appendices 11
4.1. Safety risk assessment 11
4.1.1 Methodology and data used 11
4.1.2 Conclusion of the risk assessment 12

1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this Opinion 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 4-year Rulemaking Programme under RMT.0232 & RMT.0233 (MDM.031(A)&(B)). The scope and timescale of the task were defined in the related Terms of Reference (see process map on the title page).

The draft text of this Opinion has been developed by the Agency based on the input of the Rulemaking Group RMT.0232 & RMT.0233 (MDM.031(A)&(B)). All interested parties were consulted through NPA 2014-18. 157 comments were received from 26 interested parties, including industry, National Aviation Authorities (NAAs), and individuals.

The Agency has addressed and responded to the comments received on the NPA. The comments received and the Agency's responses are presented in the Comment-Response Document (CRD) 2014-18[3].

In addition, the Agency organised on 16 June 2015, a focused consultation meeting with Member States (MSs) and the members of Review Group RMT.0232 & RMT.0233 (MDM.031(A)&(B)) to further gather MSs' concerns about CAT SET-IMC operations and the proposed provisions.

The final text of this Opinion (i.e. Explanatory Note and draft regulation(s)) has been developed by the Agency based on the input of the above-mentioned Review Group and on the MSs input during the focused consultation.

The process map on the title page summarises the major milestones of this rulemaking activity.

1.2. The structure of this Opinion and related documents

Chapter 1 of this Opinion contains the procedural information related to this task. Chapter 2 'Explanatory Note' explains the core technical content and refers to the draft rule text proposed by the Agency, which is published on the Agency's website[4].

1.3. The next steps in the procedure

This Opinion contains proposed changes to European Union (EU) regulations. The Opinion is addressed to the European Commission to be used as a technical basis in order to prepare a legislative proposal.

---

1 Regulation (EC) No 216/2008 of the European Parliament and of 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).

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 2013.

3 http://easa.europa.eu/document-library/comment-response-documents

4 http://easa.europa.eu/document-library/opinions

For information, the Agency will publish, together with this Opinion, the draft text of the related Agency ED Decision containing the Acceptable Means of Compliance (AMC) and Guidance Material (GM) in CRD 2014-18. The final Decision adopting the AMC/GM will be published by the Agency when the related Implementing Rule is adopted by the European Commission.

2. Explanatory Note

2.1. Issues to be addressed

The main issues addressed by this Opinion are the following:

— A level playing field issue since certain MSs currently allow some of their operators to operate CAT SET-IMC flights under an exemption from Regulation (EEC) No 3922/91[5] (hereinafter referred to as the 'EU-OPS Regulation'). 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 operations. 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 Standards and Recommended Practices (SARPs) allowing CAT SET-IMC operations are applicable since 2005.

— An harmonisation issue since some other major foreign aviation authorities (FAA, TCCA, CASA) have been allowing CAT SET-IMC operations for quite a long time.

— An environmental issue since the current regulatory status does not promote the use of modern aeroplanes having a better environmental footprint, especially regarding lead and carbon monoxide (CO) emissions.

— An economic issue since the current situation prevents, due to performance or operating cost considerations, the opening of new low-density routes which could be operated safely and efficiently only by single-engined turbine aeroplanes.

— A social issue since the current situation prevents the opening of new routes in remote areas and, therefore, reduces the possibility of movement of the population living in remote areas.

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 2.1. The specific objective of this proposal is, therefore, to allow single-engined turbine aeroplanes, meeting specified power plant reliability, equipment, operating, and maintenance requirements, to conduct CAT SET-IMC operations at night and/or in IMC (except under special Visual Flight Rules (VFR)).

2.3. Outcome of the consultation

157 comments were submitted by 26 commentators, including 8 EU NAAs, 2 aircraft manufacturers, 7 air operators and several associations. The comments mainly supported the proposed approach. A summary of the comments on the NPA as well as the responses to the individual comments are included in CRD 2014-18. The revised draft AMC/GM are also included in said CRD.

[5] Council Regulation (EEC) No 3922/91 of 16 December 1991 on the harmonization of technical requirements and administrative procedures in the field of civil aviation (OJ L 373, 31.12.1991, p. 4).

2.4. Summary of the Regulatory Impact Assessment (RIA)

As specified in NPA 2014-18, the following options were analysed in 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	JAA NPA OPS 29 Rev 2	Draft rules for CAT SET-IMC operations based on JAA NPA OPS 29 Rev 2
2	JAA NPA OPS 29 Rev 2 + QINETIQ recommendations	Draft rules for CAT SET-IMC operations based on JAA NPA OPS 29 Rev 2 taking into consideration all QINETIQ recommendations
3	JAA NPA OPS 29 Rev 2 + additional mitigations	Draft rules for CAT SET-IMC operations based on JAA NPA OPS 29 Rev 2 taking into consideration some QINETIQ recommendations and some counterproposals from the rulemaking group.

Table 2 presents a summary of the impacts of the selected options. For more details, refer to Chapter 4 of NPA 2014-18.

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' entails a negative assessment, which means that if no regulatory actions are taken, the current situation will develop into less safe and more costly operations due to the fact that it would not encourage the replacement of currently operated old twin- and piston-engined aeroplanes by safer single-engined turboprop aeroplanes. Options 1, 2 and 3 provide the answers to these concerns. They have all been assessed with a globally positive outcome.

The impacts of Option 1 and Option 3 are considered to be very similar since Option 3 introduces only minor modifications to NPA OPS 29 Rev 2 based on proposals made by the rulemaking group to address some of the concerns raised by the QINETIQ report.

The global impact of Option 2 is less positive than that of Option 1 and Option 3 because Option 2 was found to negatively impact the economic, proportionality and regulatory coordination/harmonisation aspects.

As a conclusion, Option 3 is considered to be the most appropriate option as it would improve safety and efficiency. It would provide at least equivalent benefits in all areas compared to Option 1 (direct transposition of NPA OPS 29 Rev 2) having also some minor safety improvement, avoiding though the implementation issues foreseen for Option 2. These safety improvements are at AMC/GM level and are related to the following items:

— minimum CAT SET-IMC experience for pilots before conducting single-pilot operations;

— use of a Full Flight Simulator (FFS) or Flight Simulation Training Device (FSTD) for the training on emergency procedures rather than on the real aeroplane when an FFS or FSTD is available;

— new guidance related to the assessment of the weather conditions on landing sites for which no weather information is published; and

— recording of the operator's CAT SET-IMC experience by the Competent Authority (CA).

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

2.5. Overview of the proposed amendments

The main change to Regulation (EU) No 965/2012[6] (hereinafter referred to as the 'Air OPS Regulation') is the introduction of a specific approval procedure for CAT SET-IMC operations.

The CAT SET-IMC proposals are based firstly on the eligibility of the aeroplane intended to be used for these operations, which is determined by the reliability achieved by the engine, and by the equipment requirements met by the aeroplane, and secondly on requirements for the operator in the area of operational procedures, maintenance of the aeroplane and crew training. These proposals are similar to the Extended Twin Operations (ETOPS) concept, including as well a recording of the experience in CAT SET-IMC operations, but without any specific aeroplane certification for such operations since the aeroplanes used for them are in any case certified for Instrument Flight Rules (IFR).

[6] Commission Regulation (EU) No 965/2012 of 5 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 (OJ L 296, 25.10.2012, p. 1).

The specific approval for CAT SET-IMC operations is proposed to be introduced as a new Subpart L of Annex V (Part-SPA) to the Air OPS Regulation. This new Subpart L includes a set of rules specific for this type of operations, including requirements on the turbine engine reliability, the maintenance of the aeroplane, the flight crew training and composition, and the operational procedures to be established and implemented by the operator.

In addition, the Air OPS Regulation is proposed to be amended as follows to accommodate the requirements introduced in Subpart L:

(a) the Cover Regulation is amended to establish the applicability of Subpart L and to remove the specific provisions related to the existing exemptions granted in accordance with Article 8(2) of the EU-OPS Regulation, as well as to CAT SET-IMC operations;

(b) Annex II (Part-ARO) 'Authority Requirements for Air Operations' is amended to provide an amended operations specification template which includes the specific approval for CAT SET-IMC operations;

(c) Annex III (Part-ORO) 'Organisation Requirements for Air Operations' provides provisions on CAT SET-IMC operations with a single-pilot crew;

(d) Annex IV (Part-CAT) 'Commercial Air Transport Operations' requirements are amended to remove the interdiction of CAT SET-IMC operations and to include some specific considerations and/or alleviations for CAT SET-IMC operations due to the nature of these operations.

Said proposal is contained in the Annex to the draft Commission Regulation.

Done at Cologne, 11 November 2015

Patrick Ky

Executive Director

3. References

3.1. Affected regulations

Commission Regulation (EU) 965/2012 of 5 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 (OJ L 296, 25.10.2012, p. 1), specifically:

— Cover Regulation;

— Annex II (Part-ARO) — Authority Requirements for Air Operations;

— Annex III (Part-ORO) — Organisation Requirements for Air Operations;

— Annex IV (Part-CAT) — Commercial Air Transport Operations; and

— Annex V (Part-SPA) — Specific Approvals.

3.2. Affected decisions

— Decision 2014/025/R of the Executive Director of the Agency of 28 July 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-ARO of Regulation (EU) No 965/2012 and repealing Decision 2014/014/R of the Executive Director of the Agency of 24 April 2014 ('AMC and GM to Part-ARO — Issue 3');

— Decision 2014/017/R of the Executive Director of the Agency of 24 April 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-ORO of Regulation (EU) No 965/2012 and repealing Decision 2012/017/R of 24 October 2012 'AMC and GM to Part-ORO — Issue 2';

— Decision 2014/015/R of the Executive Director of the Agency of 24 April 2014 adopting Acceptable Means of Compliance and Guidance Material to Part-CAT of Regulation (EU) No 965/2012 and repealing Decision 2012/018/R of the Executive Director of the Agency of 24 October 2012 'AMC and GM to Part-CAT — Issue 2'; and

— Decision N° 2012/019/Directorate 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 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 'Acceptable Means of Compliance and Guidance Material to Part-SPA'.

3.3. Reference documents

— ICAO Annex 6 — Operation of Aircraft, Part I — International CAT — Aeroplanes, last amended by Amendment 38, applicable as of 13 November 2014, specifically:

- Chapter 5.4,
- Appendix 3, and
- Attachment H;

— Federal Aviation Authority (FAA) Advisory Circular (AC) 23.1309-1E — System Safety Analysis and Assessment for Part 23 Airplanes, 17 November 2011;

— QINETIQ report QINETIQ/EMEA/IX/CR0800029/2 — Risk assessment for European Public Transport Operations using Single Engine Turbine Aircraft at Night and in IMC, 15 October 2007;

— Joint Aviation Authorities (JAA) Notice of Proposed Amendement (NPA) OPS 29 Revision 2, 1 June 2004;

— DOT/FAA/AR-05/24 — An inferred European Climatology of Icing Conditions, Including Supercooled Large droplets, June 2005;

— Council Regulation (EEC) No 3922/91 of 16 December 1991 on the harmonization of technical requirements and administrative procedures in the field of civil aviation (OJ L 373, 31.12.1991, p. 4);

— R. Leander, Climatology of low visibility for Amsterdam Airport Schiphol, July 2010; and

— Journal of Systems Engineering and Electronics 2009, — Engineering approach for human error probability quantification.

4. Appendices

4.1. Safety risk assessment

In order to assess the risk of CAT-SET operations, a formal risk assessment of CAT SET-IMC operations has been established by the Agency. Eight main scenarios have been identified and, for each of them, an evaluation of the consequences in terms of probability and severity, firstly without any specific mitigation and, secondly, considering the proposed mitigations.

The main aim of this risk assessment is to determine if the proposed mitigations allow the achievement of the selected target fatal accident rate.

The proposed mitigations are in the following areas:

— eligibility of aeroplanes, based on engine reliability and equipment requirements;

— operational procedures, including flight planning procedures and in-flight abnormal and emergency procedures;

— aircraft maintenance; and

— crew training and minimum experience.

This risk assessment is based on the selected power plant reliability rate of 10 per million flight hours.

It should be noted that, in addition to the QINETIQ report and JAA NPA OPS 29 Rev 2 data, this risk assessment relies on some other public data or figures, which are referred to in Chapter 3.3 above.

The conclusion of this risk assessment is that the proposed mitigations are found sufficient to at least reach the required target fatal accident rate for CAT SET-IMC operations, and that no further mitigation is specifically required to reach this target.

4.1.1 Methodology and data used

The initial eight scenarios, as presented in NPA 2014-18, have been analysed and set out as a Fault Tree Analysis (FTA) in order to be able to specify the extent to which the scenarios overlapp.

A general FTA (Figure 1) has been first established to first determine how each scenario applies to each phase of the flight and to specific conditions related to the flight. This allows to more clearly apply the appropriate likelihood factors based on these characteristics.

Based on this general FTA, a risk exposure diagram (Figure 10) has been established to determine if there is significant interaction between the scenarios. The establishment of Figure 10 is based on the following steps:

— the applicability of each scenario has been considered for the two different phases of flight (cruise, take-off/approach/landing);

— the probability of each escalation factor as established in each scenario (e.g. 7 % for icing conditions as established in Scenario 1) has been regarded as a starting point;

— a weighted probability dependent on the phase of flight has been established using a 89 % and a 11 % ratio respectively (89% for the cruise phase, and 11% for the take-off, approach and landing phases);

— the same process has been followed for the case of a landing site being available when a loss of power occurs and/or when no landing site is available (use of a risk period); and

— finally, the sum of these different exposure factors has been established.

Figure 10 provides a resulting number of 110 %, which represents a gross overlap of 10 %. This overlap indicates a low level of interaction between the different scenarios. Therefore, the risk assessment does not address any interacting events since the resulting error is considered to be acceptable.

For each scenario, a specific factor is used to determine the probability of performing a safe forced landing. This factor is derived from a study performed by the JAA in 2004 when drafting NPA OPS 29 Rev 2. This study is related to the evaluation of the success rate of forced landings consecutive to an engine loss of power (ref.: JAA/SE-IMC WG/2003/01). It has taken into account all forced landings with engine involvement from the entry into service until 2002 including all three known eligible types (C208, TBM700 and PC12) and all countries where aviation standards are considered to be similar to the EU ones (e.g. USA, Canada, Australia, New Zealand). Only 12 % of the forced landings have resulted in fatalities. It should be noted that it included both commercial and private operations and that, therefore, this rate is quite conservative if only commercial operations would be considered.

This observed rate has been used as the baseline figure for all the scenarios assessed in the safety risk assessment. Nevertheless, and especially in the unmitigated assessment, higher rates have been used compared to the baseline rate to take into account the scenarios'conditions.

The following rates have been derived from the baseline rate:

— 25 %: conditions that are expected to limitedly reduce safety margins;

— 50 %: conditions that are expected to significantly reduce safety margins; and

— 75 %: conditions that are expected to largely reduce safety margins.

4.1.2 Conclusion of the risk assessment

The unmitigated fatal accident rate is found to be 5,08 x 10-6, which is reasonably close to the historical data of 4,44 x 10-6 considered in NPA 2014-18. Nevertheless, more conservative figures have been used to establish the safety risk assessment and, therefore, this might explain the higher value.

The proposed mitigated fatal accident rate on the other hand is found to be 2,46 x 10-6, which is below the selected target fatal accident rate of 4 x 10-6. It can, therefore, be concluded that the proposed mitigation is appropriate to allow for safe operations.

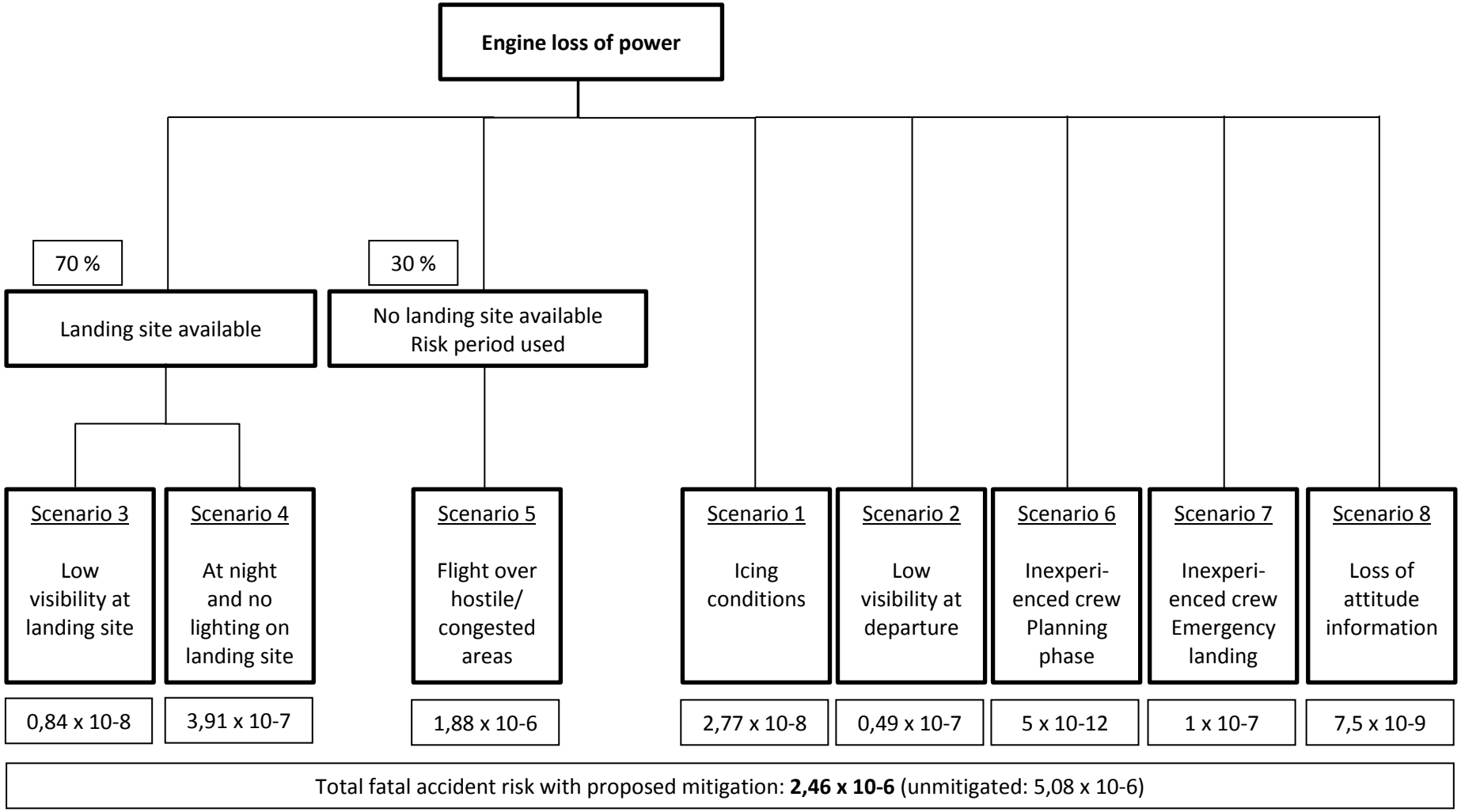

Figure 1: General FTA

Scenario 1: Icing conditions

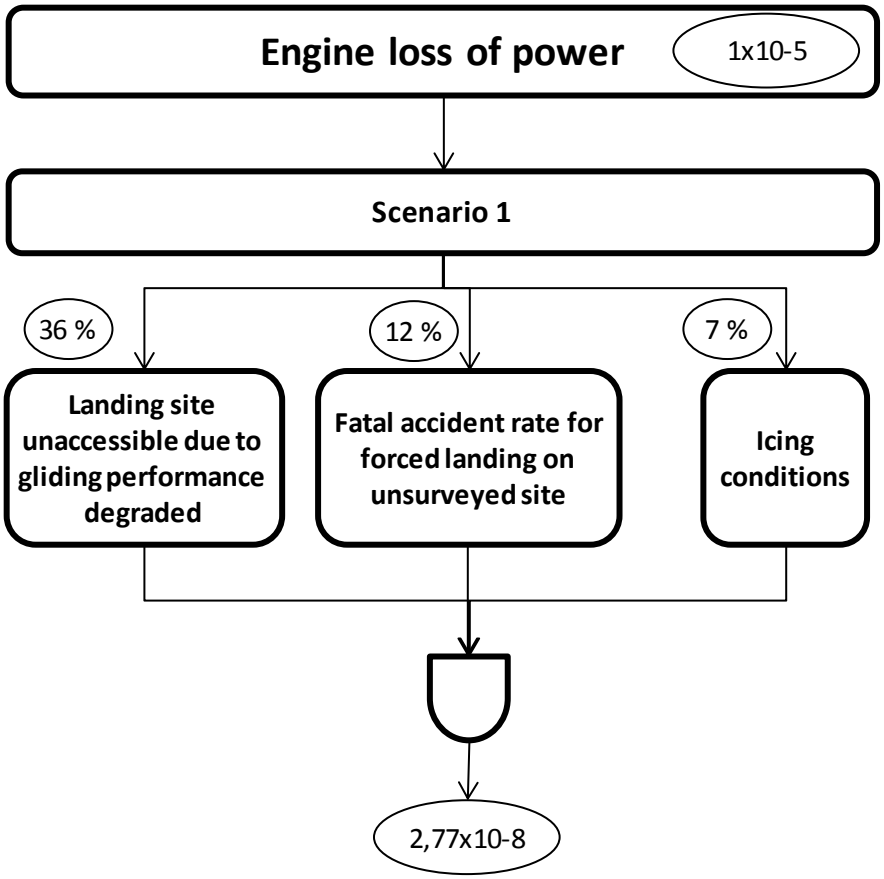

Figure 2: Scenario 1

The figure related to the probability of encountering icing conditions (7 %) is extracted from a report issued by the FAA: DOT/FAA/AR-05/24 'An inferred European Climatology of Icing Conditions, Including Supercooled Large droplets'.

If icing conditions are encountered in one third of the cases only, this would result in a reduction of the gliding capacities sufficient to prevent the planned landing on the identified safe forced landing area, and would, therefore, oblige the flight crew to land on an unsurveyed site, not necessary hostile or congested. The baseline fatal accident rate (see 4.2.1 above) has, hence, been taken into account.

It is concluded that the current mitigations for this scenario provide adequate protection and no additional mitigation is necessary.

Scenario 2: Low visibility at the departure aerodrome

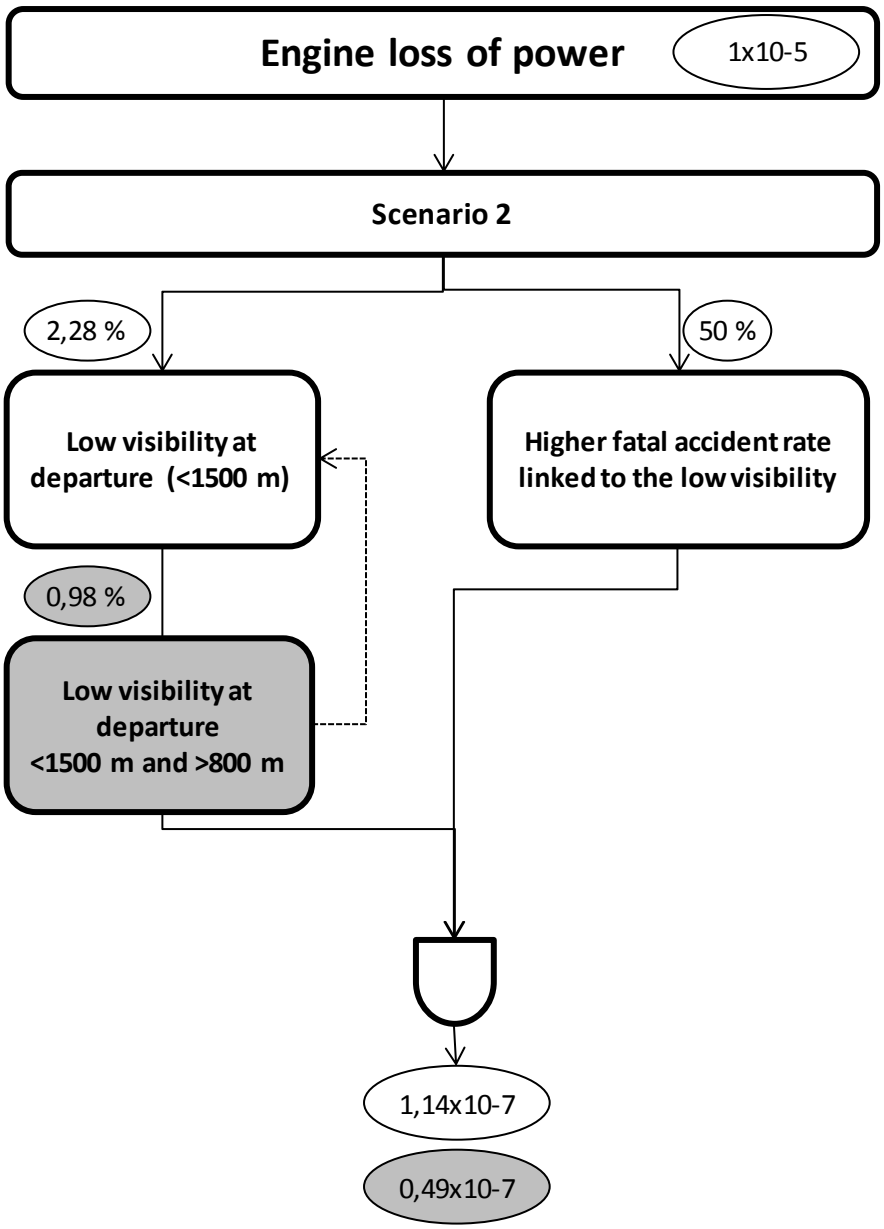

Figure 3: Scenario 2

The figures related to the probability of encountering Runway Visual Range (RVR) below 1500 m and RVR between 800 and 1500 m are derived from the following report: 'Climatology of low visibility for Amsterdam Airport Schiphol'. On an average basis, the Amsterdam Airport Schiphol weather conditions are representative of European weather conditions, taking into account its central location.

Considering take-off in low visibility conditions, the fatal accident probability is increased to 50 %.

It is concluded that the current mitigations for this scenario provide adequate protection and no additional mitigation is necessary.

Scenario 3: Low visibility at landing sites

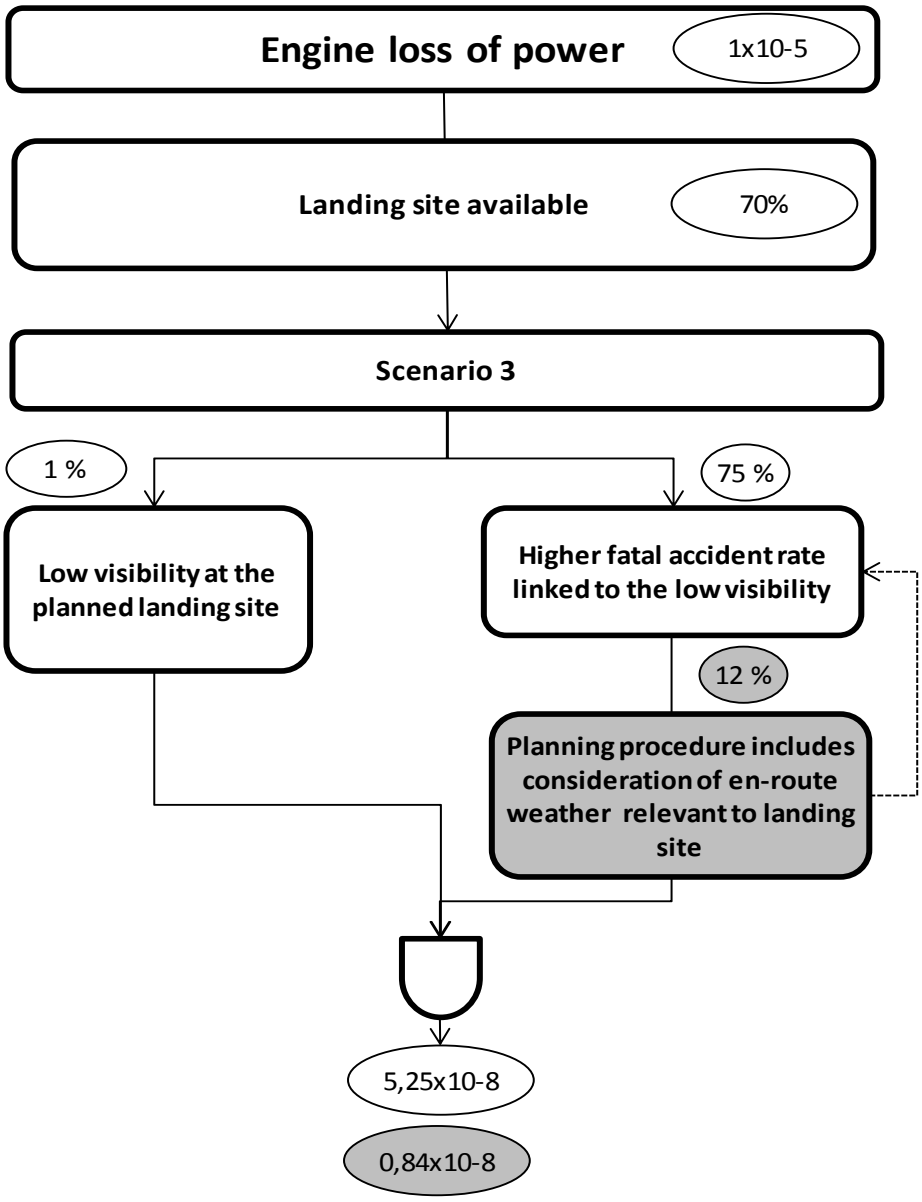

Figure 4: Scenario 3

The figures related to the probability of encountering visibilities below 550 m are derived from the following report: 'Climatology of low visibility for Amsterdam Airport Schiphol'. On an average basis, Amsterdam weather conditions are representative of European weather conditions, taking into account its central location.

Considering these low visibility conditions, the fatal accident probability is increased to 75 %.

It is considered that the appropriate planning of the flight, including an assessment of the weather prevailing at the landing site, provides an adequate mitigation and, therefore, no additional mitigation is needed.

Scenario 4: Flight at night with landing sites without lighting

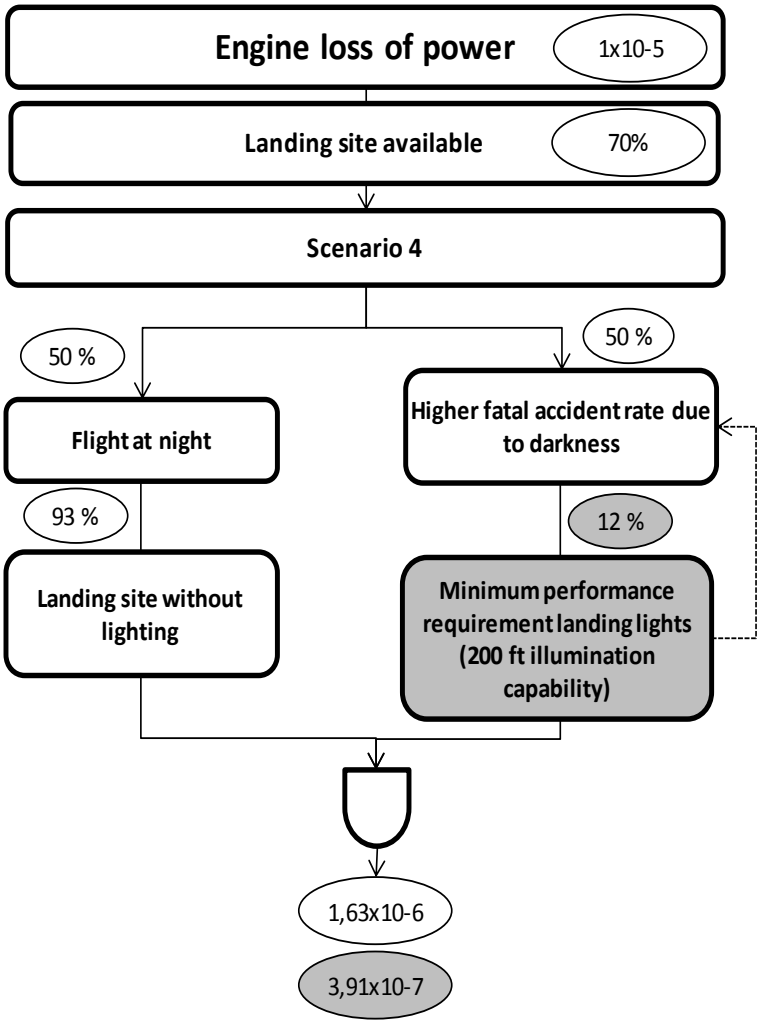

Figure 5: Scenario 4

The day/night ratio on a yearly basis has been considered to be 50 %.

Taking into account the number of aerodromes available in Europe, it is considered that 70 % of the selected emergency landing sites would be aerodromes (irrespective of the type of the runway surface) and 30 % fields.

Out of these 70 %, it is considered that an average of 10 % of these aerodromes have a runway of at least 3 000 ft, a lighting system available and are open all the time. Consequently, the proportion of emergency landing sites with no lighting system is estimated at around 93 % of the total.

In the case of landing in dark conditions, the fatal accident probability has been increased to 50 % and aligned with the baseline situation with the proposed mitigation.

It is concluded that the current mitigations for this scenario, including an appropriate flight planning and a requirement on the illumination capability of the landing lights, provide adequate protection and no additional mitigation is necessary.

Scenario 5: Flight over congested and/or hostile environment/use of a risk period

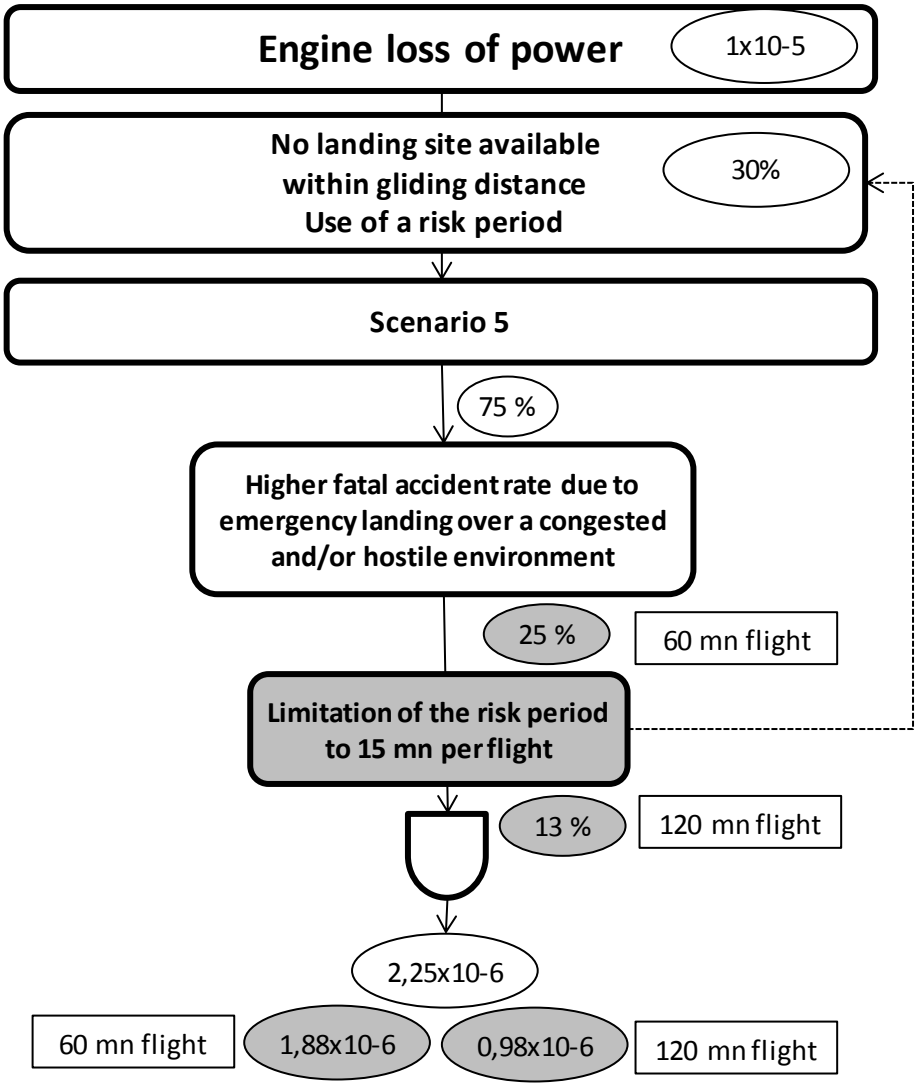

Figure 6: Scenario 5

It is considered that, based on 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 based on the operation of a C208, since this aeroplane type has the lowest operating altitude among the three main aeroplane types which are currently known to possibly meet the proposed requirements.

Considering a landing in an hostile or congested area, the fatal accident probability has been increased to 75 % in order to reflect this situation.

The mitigation is related to setting a limit to the duration of the risk period used. The effect of this mitigation will, therefore, be dependent on the average duration of the flight and, consequently, the mitigated resulting risk is calculated for two typical flight durations, that is 60 and 120 min.

It is concluded that the current mitigations for this scenario, including a limitation of the risk period duration, provide adequate protection and no additional mitigation is necessary.

Scenario 6: Crew without relevant experience related to the flight preparation

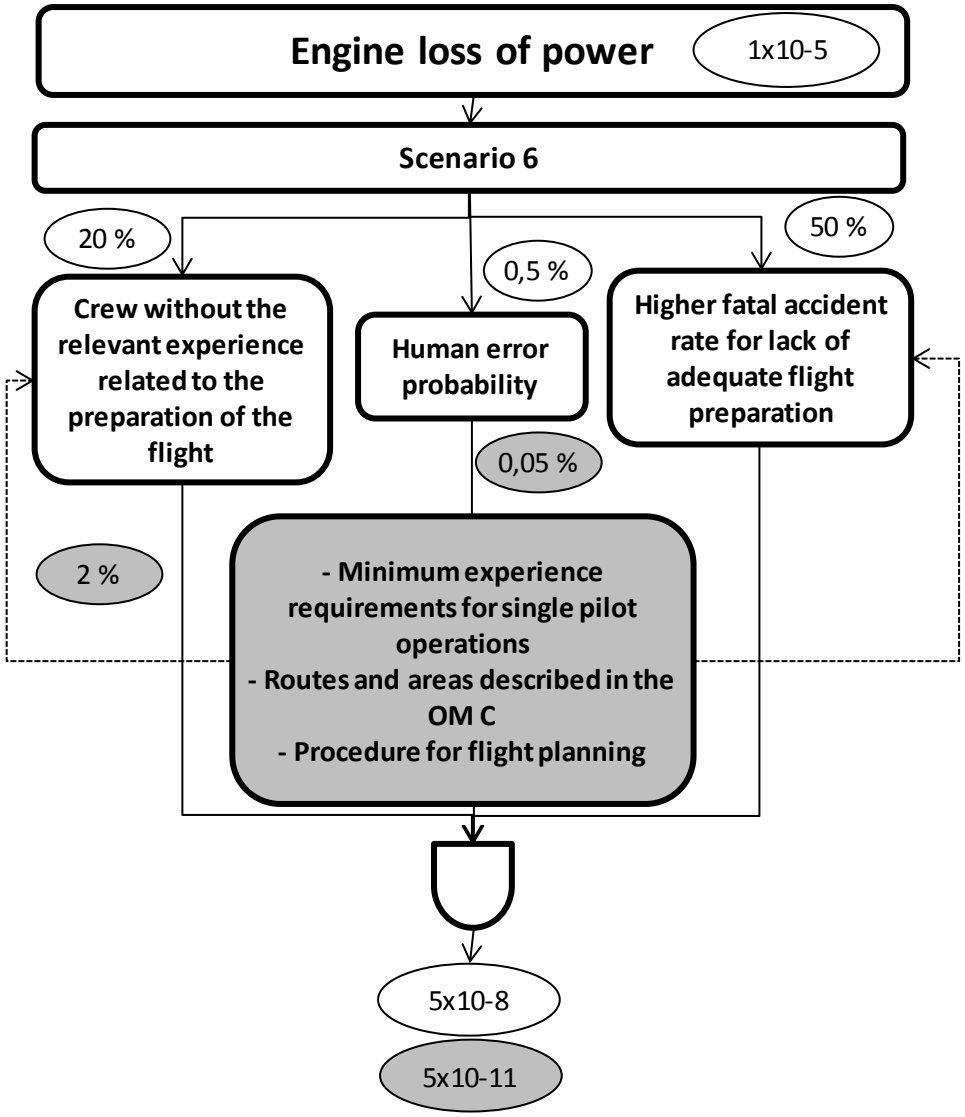

Figure 7: Scenario 6

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

The average values for the Human Error Probability (HEP) with regard to different behaviours are extracted from the Journal of Systems Engineering and Electronics 2009 'Engineering approach for human error probability quantification'.

It is estimated that, based on the type of behaviour, HEP is as shown in the table below:

Behaviour mode	HEP
Skill-based	5×10^{-4}
Rule-based	5×10^{-3}
Knowledge-based	5×10^{-2}

In a knowledge-based mode, the human carries out a task in an almost completely conscious manner. This occurs in a situation where a beginner is performing the task or where an experienced individual faces a completely new situation. In either of these cases, the worker would have to exert considerable mental effort to assess the situation, and their responses are likely to be slow.

The skill-based mode refers to the smooth execution of highly practiced, largely physical actions in which there is virtually no conscious monitoring. Skill-based responses are generally initiated by some specific event, which may arise from a warning or an alarm. The highly practiced responsive action will then be performed largely without conscious thought.

The rule-based behaviour is an intermediate state between the skill-based and the knowledge-based behaviours.

Inexperienced crew are considered to mostly act in accordance with the knowledge-based mode, and it is believed that with the proposed mitigation regarding the minimum experience requirements, flight crew would fall at least under the rule-based mode category.

Considering inexperienced crew, the fatal accident rate has been increased to 50 %.

The proportion of flight crew remaining inexperienced, despite the mitigation put in place, has been arbitrarily set at 2 %.

It is concluded that the current mitigations for this scenario provide adequate protection and no additional mitigation is necessary.

Scenario 7: Crew without the relevant experience related to the conduct of an emergency landing

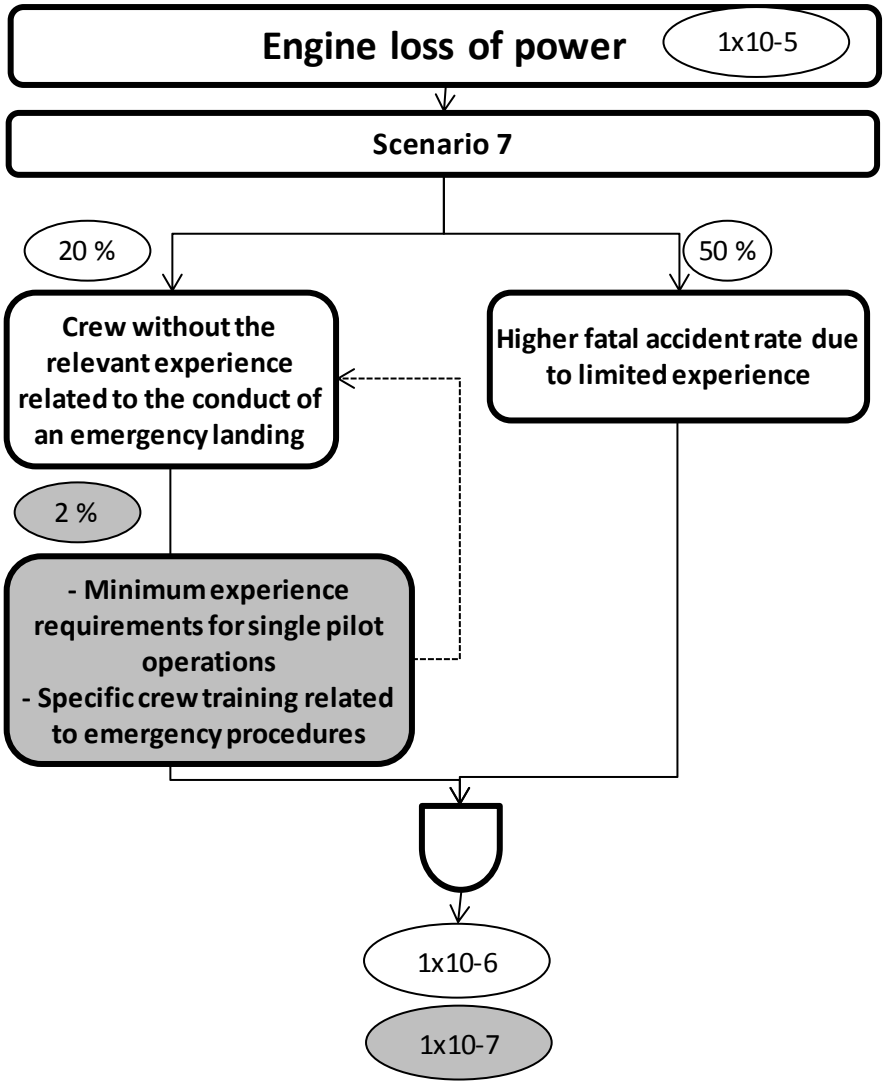

Figure 8: Scenario 7

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

Considering inexperienced crew, the fatal accident probability has been increased to 50 %.The proportion of flight crew remaining inexperienced, despite the mitigation put in place, has been arbitrarily set at 2 %.

It is concluded that the current mitigations for this scenario provide adequate protection and no additional mitigation is necessary.

Scenario 8: Loss of all means of attitude information, misleading information and/or malfunction without warning

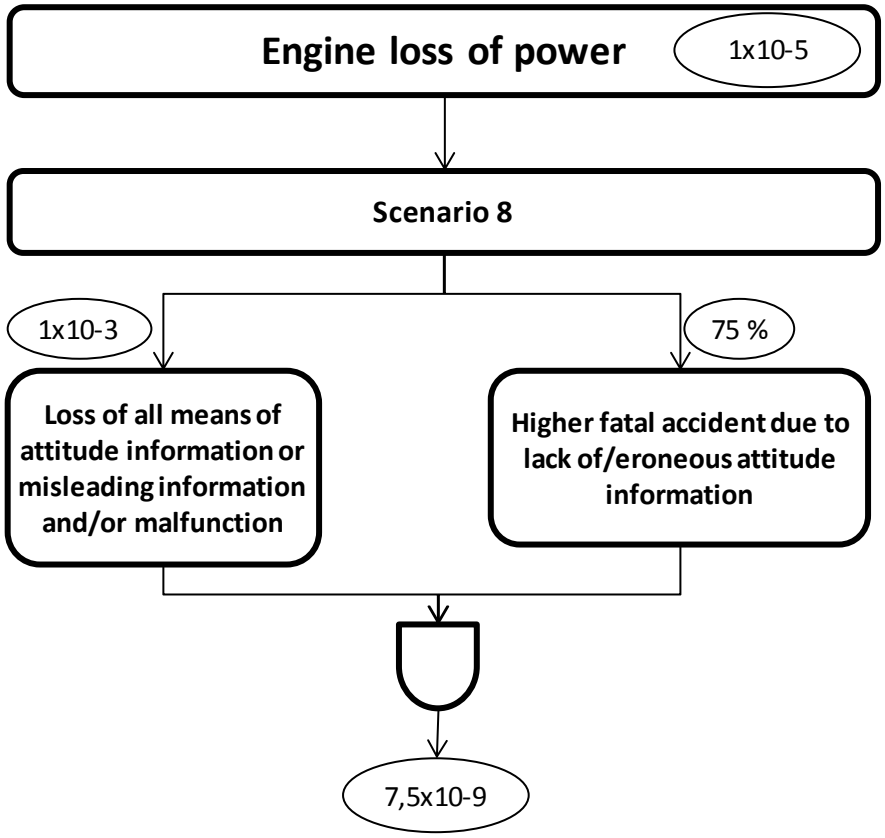

Figure 9: Scenario 8

According to FAA AC 23.1309-1E, 'Loss of all means of attitude information' and 'Misleading and/or Malfunction Without Warning' are classified as being catastrophic, and the corresponding 'Allowable Qualitative Probability' for a Class III aeroplane is 1.0 x 10-8 . Hence, the assumed probability of 1.0 x 10-3 is a conservative figure.

Considering the lack of attitude information, the fatal accident probability has been increased to 75 %.

It is concluded that no additional mitigation is necessary since adequate protection is already provided.

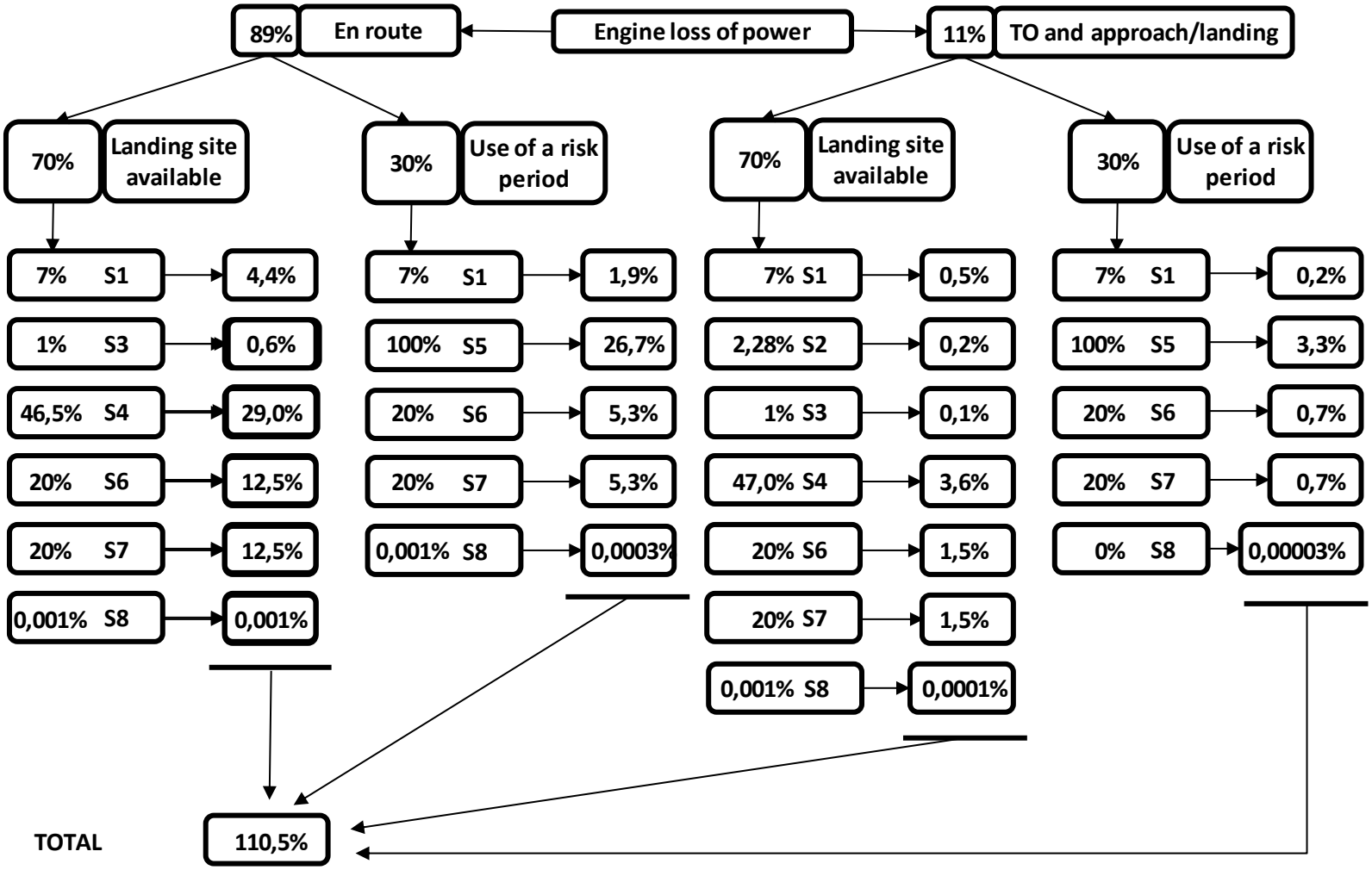

Figure 10: Risk exposure diagram