European Aviation Safety Agency

Explanatory Note to Decision 2015/008/R

CS-25 – Amendment 16

RELATED NPA/CRD 2011-03 AND 2012-22 — RMT.0058 (25.058) — 12.3.2015

EXECUTIVE SUMMARY

This Decision addresses a safety issue related to the operation of CS-25 large aeroplanes in some environmental conditions that are not, or only partially, addressed in the current CS-25.

The Decision is linked to European Aviation Safety Plan 2014-2017 (item EASp AER4.2).

The specific objective is to upgrade large aeroplanes certification specifications for flight in icing conditions (in particular severe conditions such as Supercooled Large Drop (SLD) icing or high altitude ice crystals icing) and some other weather conditions such as snow and heavy rain. This upgrade takes into account the lessons learnt from accidents and incidents, the scientific progresses made in term of knowledge of weather conditions, as well as the technological developments made to better protect the aeroplane and its systems.

This Decision introduces new environmental conditions in CS-25 along with a set of amended or new specifications requiring the applicant to demonstrate that the aeroplane or its engines and equipment will safely operate after encountering any of the defined conditions. Part of the changes are two new appendices: Appendix O describing SLD icing conditions, and Appendix P describing ice crystal and mixed phase icing conditions.

The proposed changes are expected to increase safety for new large aeroplanes.

Applicability	
Affected regulations and decisions:	CS-25; ED Decision 2003/2/RM of 17 October 2003
Affected stakeholders:	Large aeroplane manufacturers and their equipment suppliers; operators of those aircraft
Driver/origin:	Safety
Reference:	EASp 2014-2017 (item AER4.2)

Process map	
Concept Paper:	No
Rulemaking group:	No
Terms of Reference:	09.07.2010
RIA type:	Full
Technical consultation during NPA drafting:	No
Publication date of NPA 2011-03 & NPA 2012-22:	21.03.2011 & 27.11.2012
Duration of NPAs consultations:	4.5 & 5 months
Review group:	No
Focussed consultation:	No
Publication date of the Opinion:	N/A

Table of contents

1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed this ED Decision 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 for 2014-2017 under RMT.0058 (25.058)[3]. 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 Decision has been developed by the Agency. All interested parties were consulted through NPA 2011-03 and NPA 2012-22[4]. During the consultation of NPA 2011-03, 209 comments and 18 letters/attachments were received from interested parties, including national aviation authorities, professional organisations and private companies. For NPA 2012-22, 216 comments and 7 letters/attachments were received from interested parties, including national aviation authorities, professional organisations and private companies.

The Agency has reviewed the comments received on the NPA. The comments received and the Agency's responses are presented in the Comment-Response Documents (CRD) 2011-03 and 2012-22[5].

The final text of this Decision with the Certification Specifications and Acceptable Means of Compliance (AMC) has been developed by the Agency.

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

1.2. Structure of the related documents

Chapter 1 contains the procedural information related to this task. Chapter 2 explains the core technical content. Chapter 2.4 summarises the findings from the Regulatory Impact Assessment. The final text of the CS is annexed to the ED Decision.

---

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)..

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 https://www.easa.europa.eu/document-library/rulemaking-programmes

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

5 https://www.easa.europa.eu/document-library/comment-response-documents

2. Explanatory Note

2.1. Overview of the issues to be addressed

It has been evidenced that the icing environment, and other weather conditions, used for certification of large aeroplanes needs to be expanded and better considered in order to improve the level of safety when operating in these environmental conditions.

Accidents and incidents have been reported involving the presence of freezing rain and freezing drizzle, also designated as Supercooled Large Drop (SLD) icing conditions, as part of the causal factors. These icing conditions, which are beyond the current CS-25 Appendix C supercooled liquid icing conditions, can lead to substantial ice accretions on the airframe, notably on areas located behind ice protected areas. This has the potential of quickly deteriorating the aerodynamic performances of the aeroplane, and in some cases this has created stall or un-commanded roll of the aircraft, and in the worst cases loss of control situations.

Ice crystal icing has been a factor in events which involved the malfunction of some flight instrument external probes (in particular Pitot probes), or engine malfunctions (loss of thrust, or flame-out).

Service experience of different engine types installed on CS-25 aircraft has also identified the potential for a multiple engine failure during take-off, after prolonged ground operation in freezing fog.

Service history has shown that in-flight snow (and mixed phase) conditions have caused power interruptions on some turbine engines and APUs with inlets that incorporate plenum chambers, reverse flow, or particle separating design features.

Finally, heavy rain condition encountered in flight has created malfunctions of some flight instrument external probes (i.e. Pitot probes).

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 introduce in CS-25 new environmental conditions (i.e. icing conditions and others like heavy rain, snow) along with a set of amended or new specifications requiring the applicant to demonstrate that the aeroplane or its engines and equipment will safely operate after encountering any of the defined conditions. Associated to these specifications, new or revised acceptable means of compliance and guidance material are also introduced.

The final goal is to upgrade the safety level of large aeroplanes operating in icing conditions (in particular severe conditions like SLD icing or high altitude ice crystals icing) and some other weather conditions (snow, heavy rain).

Note: Rulemaking task RMT.0179 (E.009) has been conducted in parallel to RMT.0058 to also amend the CS-E (Engines) provisions for ice protection of turbine engines, and the related CS-E amendment will be published simultaneously with this CS-25 amendment. CS-E 780 is amended to require the engine to function satisfactorily throughout the conditions of atmospheric icing, including freezing fog, and in falling and blowing snow which are defined in the turbine engines air intake system ice protection specifications of the Certification Specifications applicable to the aircraft on which the

engine is to be installed. This ensures consistency between the specifications applicable to the engine and the ones applicable to the air intake system at aircraft level.

2.3. Outcome of the consultation

A) Contentious item: From the comments received on both NPA 2011-03 and NPA 2012-22, it has been highlighted that some manufacturers of the highest category of CS-25 aeroplanes, e.g. Airbus, Boeing, Mitsubishi, were concerned by one part of the EASA proposal, i.e. with regard to the applicability of the new rule to demonstrate safe operation of the aircraft after encountering SLD (Supercooled Large Droplet) icing, i.e. CS 25.1420; the EASA rule is applicable to any CS-25 aeroplanes, and this corresponds to the majority position held in the IPHWG group (by ALPA, CAA UK, FAA/FAA Tech Center, Meteorological Services of Canada, NASA, SAAB, TCCA/TDC). These manufacturers supported the minority position held within the IPHWG group (by Airbus, Boeing, and Embraer, supported by Cessna) which would exclude aeroplanes with certain design features from compliance to the new CS 25.1420 rule; the three design features were: gross weight in excess of 60 000 pounds (27 000 kg), irreversible flight controls, and wing leading edge high-lift devices. This position was based on the review of accidents and serious incidents which did not involve aeroplanes in the large category equipped with the mentioned design features.

The majority position of the IPHWG on its side considered that one cannot predict with confidence that the past service experience of aeroplanes with specific design features will be applicable to future designs, and therefore the new CS 25.1420 rule must apply to all future transport category aeroplane designs.

Furthermore, the FAA published an NPRM (Notice 10-10; Docket No. FAA-2010-0636) proposing a new FAR § 25.1420 rule which would apply only to aeroplanes with a Maximum Take-Off Weight less than 60 000 pounds or with reversible flight controls. This decision, contrary to the FAA technical position in the majority position of the IPHWG, was taken in order to 'propose a rule with the estimated costs commensurate with the estimated benefits' which has been confirmed in the FAA final rule dated 4 November 2014 (Federal register Vol.79, No. 213: Amendment 25-140; Docket No. FAA-2010-0636) and was used as another argument by the manufacturers mentioned above, i.e. that the Agency should consider harmonising the rule with the FAA rule.

Transport Canada Civil Aviation (TCCA) supported the CS 25.1420 rule when commenting on NPA 2011-03, which is consistent with their position within the IPHWG.

In addition, several large aeroplane manufacturers expressed concerns about the complexity to show compliance to the new SLD icing specifications, because of the limited maturity of the simulation tools available (i.e. CFD tools, icing wind tunnels, aircraft icing tanker) and the difficulty and cost of a flight test campaign in SLD icing especially if it is needed to find the most severe SLD icing conditions.

In response to these comments, the Agency decided to maintain a CS 25.1420 rule which is applicable to all applicants, based on the fact that 1): the SLD environment can be encountered by any large aeroplanes whatever its design, and 2): it is not possible to automatically claim that the past service experience of aeroplanes with specific design features will be applicable to any future design.

Nevertheless, the Agency has recognised that many aeroplanes have demonstrated, by extensive operation in icing conditions, that they can safely fly in SLD icing conditions.

For this reason, the Agency proposed some provisions in the corresponding Acceptable Means of Compliance (AMC) material in NPA 2012-22 so that the applicant may use and take credit from similarity to a previous design having proven safe operation in SLD icing conditions. This would facilitate the demonstration of compliance with the specifications and it may remove the need for performing testing in natural or simulated SLD conditions. As the details of the method and the acceptance criteria to be used when conducting a similarity analysis are not provided in the proposed AMC material mentioned above, the Agency decided to create a new rulemaking task to prepare a proposal that will further develop the above proposal. This would then provide a better assurance to applicants on the conditions required for a similarity analysis to be accepted by the Agency. This would also facilitate the certification process for both industry and the Agency.

This rulemaking task RMT.0572 started in January 2013 with the publication of its terms of reference (ToR). The NPA has been drafted and will be published after this ED Decision amending CS-25.

B) Outside of the contentious item described above, the comments received on NPA 2011-03 and NPA 2012-22 allowed to improve the proposed specifications and clarify or further develop some guidance material and acceptable means of compliance. Please refer to the corresponding CRDs for details of the specific responses provided and changes made to the proposed CS-25 text.

2.4. Summary of the Regulatory Impact Assessment (RIA)

Safety: A safety benefit is expected by preventing the occurrences of aircraft loss of control, engine power losses or flameouts and flight instrument external probes malfunctions when operating in icing conditions, snow or heavy rain. New CS-25 aeroplanes would be demonstrated for safe operation throughout the updated environmental conditions.

Environment: Additional greenhouse gas emission caused by additional fuel burn (from additional SLD ice detection hardware weight). Monetary value estimated: 177.296 Euros.

Social: None.

Economic: The proposed rule total cost of 51.8 million Euros (Nominal value: 57.7 million Euros) is considered balanced by the safety benefit of 76.3 million Euros (Nominal value: 183.1 million Euros) of preventing accidents.

Proportionality issues: None.

Impact on regulatory harmonisation:

Several differences were identified between the NPA 2011-03 proposed specifications and the draft rule proposed by the FAA in their NPRM (Notice 10-10; Docket No. FAA-2010-0636):

a. The applicability of the FAA proposed § 25.21(g) and §25.1420 (Supercooled Large Droplet (SLD) icing conditions) to a certain category of aeroplanes.

b. The mixed phase and ice crystals environment proposed by FAA for Pitot tubes and Angle of Attack sensors (§25.1323 and §25.1324).

c. The applicability of the FAA proposed mixed phase and ice crystals which is limited to Pitot tubes and Angle of Attack sensors (§25.1323 and §25.1324).

d. Flight instrument external probes heat indication system

e. Figures 1 and 4 of the FAA proposed Appendix O

Please refer to CRD 2011-03, chapter IV.15 for the detailed explanations of these differences.

The differences compared to the FAA final rule are the same except for point e. which has been corrected by the FAA.

Concerning EASA AMCs, the proposal under NPA 2012-22 reflected the differences identified in the specifications mentioned above. In addition, AMC 25.1324, applicable to flight instrument external probes, provides ice crystal and mixed phase conditions beyond the CS-25 Appendix P environment (equivalent to FAA Appendix D to Part 33) which are more severe for flight probes. This has been decided by the Agency based on events of probes malfunctions in presence of higher ice crystal concentrations than the ones provided in Appendix P (which was mainly developed for turbine engines). The FAA NPRM, final rule and draft ACs do not include these conditions for flight probes.

2.5. Overview of the amendments

The main changes brought by this CS-25 amendment are summarised hereafter.

- A new Appendix O to CS-25 is created which provides a new SLD icing environment to be used for the certification of Large Aeroplanes, in addition to the existing CS-25 Appendix C icing environment. The Appendix O is structured in two parts like the existing Appendix C. The first part specifies the SLD icing conditions and the second part defines the ice accretions to be considered, based on the conditions provided in the first part.
- A new CS 25.1420 adds requirements that must be met in SLD icing conditions for large aeroplanes to be certified for flight in icing conditions. This change requires evaluating the operation of these aeroplanes in the SLD icing environment, developing a means to differentiate between different SLD icing conditions, if necessary, and developing procedures to exit all icing conditions, if necessary. The rule requires consideration of the SLD icing conditions (freezing drizzle and freezing rain) defined in the new CS-25 Appendix O, part I, in addition to the existing CS-25 Appendix C icing conditions. Three options are available:
    1) Detect Appendix O conditions and then operate safely while exiting all icing conditions (CS 25.1420(a)(1));
    2) Safely operate in a selected portion of Appendix O conditions, detect when the aeroplane is operating in conditions that exceed the selected portion, and then operate safely while exiting all icing conditions (CS 25.1420(a)(2)); and
    3) Operate safely in all of the Appendix O conditions (CS 25.1420(a)(3)).
- Performance and handling qualities specifications are updated: The new CS 25.21(g)(2) identifies the performance and handling qualities requirements that must be met to ensure that an aeroplane certified to either the proposed CS 25.1420(a)(1) or (a)(2) could safely exit icing if the icing conditions of proposed Appendix O, for which certification is not sought, are encountered. The new CS 25.21(g)(3) identifies the requirements for safe operation in all or any portion of the

proposed Appendix O icing conditions. The requirements for safe operation in all or any portion of the proposed Appendix O icing conditions under CS 25.21(g)(3) are similar to those currently required for Appendix C icing conditions. The list of CS-25 Subpart B requirements that currently do not have to be met for flight in Appendix C icing conditions do not have to be met in Appendix O icing conditions. For continued operation in Appendix O icing conditions, there should effectively be no degradation in handling qualities from the minimum standards established by CS-25 Subpart B specifications, and any degradation in performance should be no greater than that allowed by the rules for Appendix C icing conditions. The applicable subpart B specifications have been amended to add the reference to Appendix O for ice accretions definition (CS 25.105, 25.111, 25.119, 25.121, 25.123, 25.125, 25.143, 25.207, 25.237, 25.253).

- A new Appendix P to CS-25 is created with provides a new ice crystals and mixed phase icing environment.
- Components, Powerplant, and APU requirements: Several specifications are amended or created in order to introduce Appendix O, Appendix P, ground freezing fog, snow, or heavy rain, as applicable, in addition to Appendix C icing conditions: windshields (25.773), powerplant (25.903, 25.929, 25.1093), flight instrument external probes (25.1323, 25.1324, 25.1325, 25.1326), APU (25J1093).
- Operating limitations: For powerplant, a new sub-paragraph to CS 25.1521 is created to add some operational limitations derived from the conditions demonstrated under CS 25.1093(b)(2)(i.e. maximum time interval between engine run-ups from idle, run-up power setting, duration at power, and the associated minimum ambient temperature, if any). For essential APUs CS 25J1093 requires to identify the equivalent operating limitations.

  At the aircraft level, CS 25.1533 is amended to prohibit intentional flight into the Appendix O conditions for which the aeroplane has not been certified and require exiting all icing conditions after encountering Appendix O conditions for which the aircraft has not been certified.
- In order to support the demonstration of compliance to the amended or new specifications above, the corresponding AMCs have been amended or created.

For further explanations on the changes made, please refer NPA/CRD 2011-03 and NPA/CRD 2012-22.

3. References

3.1. Related regulations

Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations. Annex III (organisation requirements for air operations): CAT.OP.MPA.255 Ice and other contaminants — flight procedures, CAT.IDE.A.125 Operations under VFR by day — flight and navigational instruments and associated equipment, CAT.IDE.A.130 Operations under IFR or at night — flight and navigational instruments and associated equipment, CAT.IDE.A.165 Additional equipment for operations in icing conditions at night. Annex VI (Non-commercial operation with complex motor-powered aircraft): NCC.OP.190 Ice and other contaminants — flight procedures, NCC.IDE.A.120 Operations under VFR — flight and navigational instruments and associated equipment, NCC.IDE.A.125 Operations under IFR — flight and navigational instruments and associated equipment, NCC.IDE.A.150 Additional equipment for operations in icing conditions at night

3.2. Affected decisions

ED Decision No. 2003/2/RM of 17 October 2003 (CS-25 initial issue)

3.3. Reference documents

IPHWG task 2 report rev. A, dated December 2005

IPHWG task 2 report including phase IV review, dated June 2009

Federal Aviation Administration (FAA) of the USA, NPRM dated 29 June 2010 (Federal register Vol. 75, No. 124: Docket No. FAA-2010-0636; Notice 10-10;)

Federal Aviation Administration (FAA) of the USA, Final rule dated 04 November 2014 (Federal register Vol.79, No. 213: Docket No. FAA-2010-0636; Amendment 25-140)