



European Aviation Safety Agency

## Explanatory Note to Decision 2015/009/R

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# Ice Protection of Turbine Engines Volcanic Ash Engine Vibration Surveys

‘CS-E — Amendment 4’

12.3.2015



An agency of the European Union

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# Ice Protection of Turbine Engines

RELATED NPAs/CRDs 2011-04 AND 2012-23 — RMT.0179 (E.009) — 12.3.2015

## EXECUTIVE SUMMARY

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

The Decision is linked to the European Aviation Safety plan (EASp AER4.2).

The specific objective is to upgrade turbine Engines Certification Specifications for flight in icing conditions (in particular, severe conditions like Supercooled Large Drop (SLD) icing or high altitude ice crystals icing) and certain other weather conditions (i.e. snow) for Engines to be installed on CS-25 large aeroplanes. This upgrade is being made together with a corresponding upgrade of CS-25, and it takes into account the lessons learnt from accidents and incidents to large aeroplanes and turbine Engines, the scientific progresses made in terms of knowledge of weather conditions, as well as the technological developments made to better protect the Engines.

A new icing environment (including Supercooled Large Drop (SLD) icing conditions, mixed-phase and ice crystal icing conditions) is being concurrently introduced in CS-25, along with an upgrade of the specifications for air intake system ice protection; these changes were developed under rulemaking task RMT.0058 (25.058). CS-E 780 has been amended to require the Engine to function satisfactorily throughout the conditions of atmospheric icing, including freezing fog, 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.

A clarification has also been made concerning the Engine bleeds and mechanical power offtakes to be considered when showing compliance with the specifications of CS-E 780.

The proposed changes are expected to increase safety for new turbine Engines to be installed on CS-25 large aeroplanes.

Applicability		Process map	
Affected regulations and decisions:	ED Decision 2003/009/RM; CS-E	Concept Paper:	No
Affected stakeholders:	Turbine Engine manufacturers; large aeroplane manufacturers; operators of those aircraft/Engines.	Rulemaking group:	No
Driver/origin:	Safety.	Terms of Reference:	03.11.2008
Reference:	EASp AER4.2.	RIA type:	Full
		Technical consultation during NPA drafting:	No
		Publication date of NPA 2011-04 & NPA 2012-23:	22.03.2011 & 6.12.2012
		Duration of NPAs consultations:	4.5 & 5 months
		Review group:	No
		Focussed consultation:	No
		Publication date of the Opinion:	N/A



## Ice Protection of Turbine Engines

### 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<sup>1</sup> (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure<sup>2</sup>.

This rulemaking activity is included in the [Agency's Rulemaking Programme](#) under RMT.0179 (E.009). 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 2011-04 and NPA 2012-23<sup>3</sup>. During the consultation of NPA 2011-04, 32 comments and 3 letters/attachments were received from interested parties, including National Aviation Authorities (NAAs), professional organisations and private companies. For NPA 2012-23, 125 comments and 10 letters/attachments were received from interested parties, including NAAs, 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 (CRDs) 2011-04 and 2012-23<sup>4</sup>.

The final text of this Decision with the Certification Specifications (CS) 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 text of the CS/AMC is annexed to the ED Decision.

<sup>1</sup> 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).

<sup>2</sup> 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.

<sup>3</sup> In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

<sup>4</sup> <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 some other weather conditions, used for certification of turbine Engines installed on CS-25 large aeroplanes need to be expanded and better considered in order to improve the level of safety when operating in these environmental conditions.

A number of incidents involving turbine Engine power losses or flameouts have been reported when flying through ice crystal and mixed-phase icing conditions. Some of these events resulted in total power loss from Engine flameouts. Although these events happened at high altitude and did not result in a fatal outcome, they are considered as a serious safety threat. This has been confirmed on most recent turbine Engine designs and shows that ice crystals/mixed-phase icing must be better taken into account during certification of turbine Engines.

Service experience of different turbine Engine types has also identified the potential for a multiple Engine failure during take-off after prolonged ground operation in freezing fog.

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

### 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-E new environmental conditions (i.e. icing conditions and snow) along with a set of amended or new requirements for the applicant to demonstrate that the turbine Engine will safely operate after encountering any of the defined conditions. Associated with these Certification Specifications, new or revised AMC/GM have also been introduced.

The final goal is to upgrade the safety level of large aeroplanes operating in icing conditions and some other weather conditions (i.e. snow).

### 2.3. Outcome of the consultation

Overall, the comments received were supportive of the proposed amendment of CS-E 780 and AMC E 780, and most of the comments intended to improve the quality and the clarity of the proposed rule and AMC material in consistence with recent industry practices and certification projects experiences. A majority of the comments were positively received by the Agency and used to revise the changed text proposal.

Regarding CS-E 780, it has been clarified that the conditions of icing and snow to be used are the ones provided in the turbine Engines air intake system ice protection specifications (CS 23.1093(b), CS 25.1093(b), CS 27.1093(b), or CS 29.1093(b)) of the CS applicable to the aircraft on which the Engine is to be installed. The paragraph dealing with the ice ingestion has been upgraded to better state the objective and criteria to be met after the ingestion of ice or after stoppage of the ice by the Engine protection device.



The main improvements in AMC E 780 address the following topics: usage of a Critical Point Analysis (CPA) for supercooled liquid water icing conditions, establishment of test points for in-flight operation, establishment of test points for ground operation, background on why the results from the medium bird ingestion test may be used to show compliance to the ice ingestion requirement, Engine air data probes, inadvertent entry into icing conditions or delayed activation of the ice protection system, and instructions for installing and operating the Engine.

Finally, it has been commented that the current state of the art, relative to the understanding of the impact of ice crystal icing conditions on turbine Engines, is not mature, and that there is no test facility available to test a complete large turbine Engine against ice crystal/mixed-phase icing conditions. Some recent events on a brand new Engine design confirmed this statement, and that efforts must be pursued to better protect the Engines. AMC E 780 recognises the existing limitations in terms of means of compliance (i.e. no validated full-scale ground test facility). Until validated full-scale ground test facilities for mixed-phase and ice crystal icing conditions are available, compliance should be based on flight test and/or analysis (supported by Engine/component tests, as necessary). Guidance is provided for conducting comparative analysis between previous designs and the new design.

#### 2.4. Summary of the Regulatory Impact Assessment (RIA)

Safety issues: A safety benefit is expected by preventing the occurrences of turbine Engine power losses or flameouts when operating in some icing or snow conditions. New turbine Engines installed on CS-25 aircraft would be demonstrated for safe operation throughout the updated atmospheric icing environment of the aircraft on which they are installed.

Environmental issues: None.

Social issues: None.

Economic issues: The proposed rule total cost of EUR 3.7 million (present value: EUR 3.4 million) is considered to be balanced by the safety and economic benefit gained through the proposed rule.

Although there has not been any catastrophic event caused by the Engines, we consider that the numerous events mentioned above are precursors of a potential fatal event.

In terms of economic benefit, the proposed rule would provide cost savings for operators by preventing aircraft diversions and Engine damages.

Proportionality issues: None.

Impact on regulatory harmonisation: The CS-E 780 rule is not fully harmonised with the Federal Aviation Administration (FAA) Final Rule, 4 November 2014 (Federal Register Vol 79, No 213: Docket No FAA-2010-0636, Amendment Nos 33-34). The CS-E 780 rule extends the icing environment of turbine Engines installed on CS-25 aircraft, although the FAA rule would require certification of any turbine Engine, except turboshaft Engines, throughout the new environment.

Moreover, the FAA Final Rule includes detailed criteria for analysis and tests; CS E-780 instead provides objectives, and further guidance and acceptable means of compliance are detailed in the revised AMC E 780.



## 2.5. Overview of the amendments

CS-E 780 has been amended to take into account the above-mentioned new environmental conditions for installation of turbine Engines on large aeroplanes, through a link with the amended CS 25.1093(b). A new sub-paragraph CS-E 780(f) has been created to require protection of the Engine against the risk of ice ingestion. A clarification is also provided on the Engine bleeds and mechanical power offtakes to be considered when showing compliance with CS-E 780(a).

As Engine testing is not the only purpose of CS-E 780, the title has been changed to read 'Icing Conditions'.

Consequently, AMC E 780 has been fully revised to provide guidance material and acceptable means of compliance adapted to the new CS-E 780 requirements.





### 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 pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1):

- ANNEX IV (COMMERCIAL AIR TRANSPORT OPERATIONS)  
[PART-CAT]:
  - 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; and
  - CAT.IDE.A.165 Additional equipment for operations in icing conditions at night.
- ANNEX VI (NON-COMMERCIAL OPERATION WITH COMPLEX MOTOR-POWERED AIRCRAFT)  
[PART-NCC]:
  - NCC.OP.190 Ice and other contaminants — flight procedure;;
  - 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; and
  - NCC.IDE.A.150 Additional equipment for operations in icing conditions at night.

#### 3.2. Affected decisions

ED Decision 2003/009/RM of 24 October 2003 (CS-E — Initial Issue).

#### 3.3. Reference documents

- IPHWG, Task 2 Working Group Report on Supercooled Large Droplet Rulemaking, Revision A, December 2005;
- IPHWG, Task 2 Working Group Report on Supercooled Large Droplet Rulemaking, including Phase IV review, June 2009;
- US Federal Aviation Administration (FAA), Notice of Proposed Rulemaking (NPRM), 29 June 2010 (Federal Register Vol 75, No 124: Docket No FAA-2010-0636; Notice 10-10); and
- US Federal Aviation Administration (FAA), Final rule, 4 November 2014 (Federal Register Vol 79, No 213: Docket No FAA-2010-0636, Amendment Nos 33-34).



# Volcanic Ash

RELATED NPA/CRD 2011-17 — RMT.0364 (MDM.089) — 12.3.2015

## EXECUTIVE SUMMARY

RMT.0364 (MDM.089) is an integral part of the EASA overall strategy, which aims at maintaining continued safe flight while minimising disruption of normal flight operations in any future volcanic events.

Regulation (EC) No 216/2008 contains an obligation on manufacturers to provide operators with limitations and other information necessary to ensure that no unsafe condition will occur from exposure to environmental hazards.

The EASA Decision will benefit the industry by providing additional guidance to ensure that this obligation is fully met in respect of volcanic hazards. This Decision creates a new CS-E paragraph and a corresponding AMC to ensure that, if required by an operating rule, the susceptibility of product features to the effects of volcanic cloud hazards is established at type certification, and that limitations and information are made available to the operators.

Applicability		Process map	
Affected regulations and decisions:	ED Decision No 2003/009/RM; CS-E.	Concept Paper:	No
Affected stakeholders:	Turbine Engine manufacturers.	Rulemaking group:	No
Driver/origin:	Safety.	Terms of Reference:	No
Reference:	N/A.	RIA type:	Light
		Technical consultation during NPA drafting:	No
		Publication date of the NPA:	23.9.2011
		Duration of NPA consultation:	3 months
		Review group:	No
		Focussed consultation:	No
		Publication date of the Decision:	2015/Q1



## Volcanic Ash

### 4. Procedural information

#### 4.1. The rule development procedure

The European Aviation Safety Agency (hereinafter referred to as the 'Agency') developed ED Decision 2003M/009/R in line with Regulation (EC) No 216/2008<sup>5</sup> (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure<sup>6</sup>.

This rulemaking activity is included in the [Agency's Rulemaking Programme](#) under RMT.0364 (MDM.089).

When developing rules, the Agency is bound to follow a structured 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'

The proposed rule has taken into account the development of EU and international law (ICAO) as set out in the objectives of Article 2 of the Basic Regulation.

The draft text of this Decision has been developed by the Agency. All interested parties were consulted through NPA 2011-17<sup>7</sup>.

The Agency has reviewed the comments received on this NPA. The comments as well as the Agency's responses were presented in the Comment-Response Document (CRD) 2011-17<sup>8</sup>. Reactions to the CRD have previously been published in the Explanatory Note to Decision 2013/010/R on CS-25 — Amendment 13<sup>9</sup>.

The final text of this Decision with the Certification Specifications (CS)/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.

#### 4.2. Structure of the related documents

Chapter 4 contains the procedural information related to this task. Chapter 5 explains the core technical content and includes reactions to the CRD. Chapter 5.4 summarises the findings from the Regulatory Impact Assessment. The text of the CS/AMC is annexed to the ED Decision.

<sup>5</sup> 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).

<sup>6</sup> 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.

<sup>7</sup> In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

<sup>8</sup> <http://easa.europa.eu/document-library/comment-response-documents/crd-2011-17>

<sup>9</sup> <http://easa.europa.eu/system/files/dfu/CS-25%20Amdt%2013%20-%20Explanatory%20Note.pdf>



## 5. Explanatory Note

### 5.1. Overview of the issues to be addressed

A new approach to manage flight operations with known or forecast volcanic cloud contamination of the airspace has been developed by ICAO and published in ICAO Doc 9974 — Flight Safety and Volcanic Ash. Under this approach, the operator is accountable for assessing the risks to flight operations and for determining and implementing appropriate procedures and mitigating measures. Central to this approach is the development of a Safety Risk Assessment (SRA) that is acceptable to the NAA of the State of the Operator. In order to successfully produce such a SRA, it is essential that the operator is provided with, or has access to, specific technical data and information regarding the susceptibility of the aircraft they operate, including its Engines, to volcanic cloud related effects and any precautions that need to be taken into account.

### 5.2. Objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation. This proposal will contribute to their achievement by clarifying the existing obligation of manufacturers to address environmental hazards, and volcanic clouds in particular. Information provided by the manufacture will strengthen the interface between airworthiness and operations and contribute to the robustness of the SRA process.

The specific objective of this amendment is to create a new Certification Specification (CS-E 1050) and Acceptable Means of Compliance (AMC E 1050) related to volcanic clouds. It aims to clarify the existing obligation of manufacturers to ensure that no unsafe condition will occur from exposure to environmental hazards, by specifically identifying volcanic clouds as a hazard and the need to identify any susceptibility of aircraft features to the effects of volcanic cloud contamination. As part of the type certification for new or changed products, information necessary for safe operation will be made available to operators.

### 5.3. Outcome of the consultation

In response to the related NPA 2011-17, 119 comments were received from 32 commenters. Some of these were constructive and led to changes in the proposals. However, many of the commenters misunderstood the intent of the proposals and its limited applicability. Following publication of the CRD, a dedicated volcanic ash workshop was held in Cologne on 4 December 2012, where further explanation of the proposals was provided. The reaction period for the CRD was also extended until the end of 2012 to allow post-workshop-written reactions to be received.

In response to CRD 2011-17, the Agency received several reactions. These, together with the Agency's responses, have previously been published in the Explanatory Note to Decision 2013/010/R on CS-25 — Amendment 13<sup>10</sup>.

The main concern raised was the possible delay in providing data to operators during a new volcanic event caused by the lead time necessary to update manuals. The Agency's view is that, in the first instance, data should be communicated directly and in a timely manner to operators to ensure the

<sup>10</sup> <http://easa.europa.eu/system/files/dfu/CS-25%20Amdt%2013%20-%20Explanatory%20Note.pdf>



safety of operations. It is not the aim of the Agency to interfere with the efficient flow of information, which has been shown to be effective during previous volcanic events. However, to ensure that new information and/or limitations are captured and retained, manuals should subsequently be updated through the normal change procedures in compliance with the obligations of Part-21.

#### 5.4. Summary of the Regulatory Impact Assessment (RIA)

Three options have been identified as highlighted below:

Option No	Description
0	Baseline option: No change to CSs — Reliance on voluntary information supplied by manufacturers.
1	Amend CSs to require new or changed products, parts and appliances to be assessed for their susceptibility to volcanic cloud effects, and to provide information to operators.
2	As 1 but extended to cover all in-service aircraft.
3	As 1 but limited to 'volcanic ash' only.

A detailed analysis of the impacts of these options is presented in NPA 2011-17.

The conclusion was that the Agency prefers Option 1: Amend CSs to require new or changed products, parts and appliances to be assessed for their susceptibility to volcanic cloud effects, and to provide information to operators.

The proposed option will ensure that the operators' SRA can be completed using appropriate technical information to be provided by the manufacturers. This will minimise any disruption in flight operations due to volcanic cloud contamination and thereby minimise the costs for industry and inconvenience to the travelling public. The economic burden on the industry will be limited as this option is only applicable to new or changed products, parts and appliances.

#### 5.5. Overview of the amendments

Under CS-E 1050, the type certificate, restricted type certificate or supplemental type certificate holder will have to investigate and understand the hazards associated with exposure to the harmful effects of volcanic clouds. Such investigations may be based on a combination of experience, studies, analysis, and/or testing of parts, sub-assemblies or products. Information that can be readily used by operators in preparing their SRAs, including recommendations regarding the actual levels of ash tolerance and any operational precautions that need to be taken, will then have to be prepared and distributed.



## **6. References**

### **6.1. Related regulations**

Non applicable.

### **6.2. Affected decisions**

Decision No 2003/009/RM of 24 October 2003.

### **6.3. Reference documents**

ICAO Doc 9974 — Flight Safety and Volcanic Ash.



# Engine Vibration Surveys

RELATED NPA/CRD 2014-03 — RMT.0176 (E.004) — 12.3.2015

## EXECUTIVE SUMMARY

The Agency’s RMT.0176 (E.004) addresses a clarity-of-rules/economic issue related to compliance with CS-E 650 Vibration Surveys.

The specific objective is to clarify CS-E 650 and AMC E 650 on vibration surveys, to reflect current practice and to address practical difficulties related to the demonstration of compliance.

This Decision amends CS-E 650 and AMC E 650 to clarify the intent of the speed range requirement and the extent to which analysis may supplement test. While the scope and intent of the rule remain unchanged, certain prescriptive requirements in the rule have been moved to the AMC. AMC E 650 has been reorganised and expanded. Corresponding links with the other requirements have been updated.

The changes are expected to maintain safety, while reducing regulatory burden and increasing cost-effectiveness.

Applicability		Process map	
Affected regulations and decisions:	ED Decision No 2003/09/RM; CS-E.	Concept Paper:	No
Affected stakeholders:	Turbine Engine manufacturers.	Rulemaking group:	Yes
Driver/origin:	Legal obligation (clarity of rules); cost-effectiveness.	Terms of Reference:	22.6.2011
Reference:	N/A.	RIA type:	Light
		Technical consultation during NPA drafting:	Yes
		Publication date of the NPA:	5.2.2014
		Duration of NPA consultation:	3.5 months
		Review group:	No
		Focussed consultation:	No
		Publication date of the Decision:	2015/Q1



## Engine Vibration Surveys

### 7. Procedural information

#### 7.1. 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<sup>11</sup> (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure<sup>12</sup>.

This rulemaking activity is included in the [Agency's Rulemaking Programme](#) under RMT.0176 (E.004). 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 based on the input of the stakeholders-led drafting group for RMT.0176 (E.004) — 'Engine Vibration'. All interested parties were consulted through NPA 2014-03<sup>13</sup>. 35 comments were received from interested parties, including industry and National Aviation Authorities (NAAs).

The Agency has reviewed the comments received on the NPA with the support of the stakeholders-led drafting group RMT.0176 (E.004). The comments received and the Agency's responses are presented in the Comment-Response Document (CRD) 2014-03 which will be published together with the Decision.

The final text of this Decision with the Certification Specifications (CS)/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.

#### 7.2. Structure of the related documents

Chapter 7 contains the procedural information related to this task. Chapter 8 explains the core technical content. Chapter 8.4 summarises the findings from the Regulatory Impact Assessment (RIA). The text of the CS/AMC is annexed to the ED Decision.

<sup>11</sup> 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).

<sup>12</sup> 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.

<sup>13</sup> In accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.





## 8. Explanatory Note

### 8.1. Overview of the issues to be addressed

There are practical difficulties related to compliance with CS-E 650. In accordance with AMC E 650, 'survey' has generally been interpreted to mean a full Engine test. Recent certification experience shows that the speed range defined for the surveys may not be achievable during test cell testing without modifying the test Engine to an extent that makes it unrepresentative of the type design configuration. Furthermore, the gas turbine industry has been heavily investing in developing analytical methods with the objective of being able to accurately predict vibratory characteristics over a wide range of conditions. Clarification is needed on the intent of the speed range requirement and on the extent to which analysis may supplement test.

There is, therefore, a need to further clarify both CS-E 650 and AMC E 650 Vibration Surveys and to reflect current practice.

This proposal maintains the current level of safety and brings potential, but not easily quantifiable, economic benefit.

### 8.2. Objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation.

The specific objective of this proposal is to clarify CS-E 650 Vibration Surveys and the corresponding guidance in AMC E 650 to address practical difficulties related to showing of compliance.

### 8.3. Outcome of the consultation

There were 35 comments received from a total of 10 commenters. 5 commenters only noted the issuance of the NPA and 2 commenters expressed support for the proposed amendments. FAA has submitted the majority of the comments. Comments have been responded to in CRD 2014-03.

Highlights of the changes made by the Agency, compared to the text proposed through NPA 2014-03, are the following:

- minor wording change to CS-E 650(f) and wording clarifications on CS-E 740(g)(1);
- AMC E 650 paragraph (1) 'Module' definition was has been updated;
- AMC E 650 paragraph (8)(a) was modified to clarify the circumstances for acceptability of the flutter presence;
- AMC E 650 paragraph (14)(a) was modified to clarify the 'similarity' concept;
- AMC E 650 paragraph (14)(b)(i) was modified in various places to better define typical design characteristics and operating conditions which may constitute the domain of applicability of the validated analysis;
- AMC E 650 paragraph (14)(b)(ii) was modified in various places to better define the concept of 'similarity' and to clarify the examples where validated analysis may be used; and
- AMC E 740 paragraph (g)(1) reference to AMC E 650 was updated.



#### 8.4. Summary of the Regulatory Impact Assessment (RIA)

Only one option (Option 1) was considered (aside from the zero or Baseline Option of no change to the rule or AMC). This option was to clarify the rule and provide guidance on the use of analysis to supplement Engine or rig testing.

The main impact of Option 1 was judged to be economic. There is no safety impact, and no significant social or environmental impact.

Option 1 could be seen as introducing disharmonisation with the FAA vibration rule, FAR 33.83. It is believed, however, that the effect is minimal due to the fact that the proposal merely standardises what has become accepted certification practice, whereas the scope and intent of the rule remain unchanged.

Since Option 1 does not introduce any new requirements, rather some needed flexibility with regard to compliance, no other negative impact is foreseen.

For the industry, it is anticipated that the cost of compliance with CS-E 650 could be reduced by as much as 30–50 %, if analysis is used to supplement Engine testing. Furthermore, the clarification of the rule and the provision of a standardised approach to the allowable use of analysis are expected to reduce the administrative burden.

#### 8.5. Overview of the amendments

CS-E 650 and AMC E 650 have been amended in order to both clarify and reflect current certification practice. Certain prescriptive requirements in the rule have been moved to the AMC, but the scope and intent of the rule have not been changed. AMC E 650 has been reorganised and expanded.

CS-E 740 has been amended to clarify the link with CS-E 650. References to CS-E 650 have also been updated. AMC E 740 has been updated with the revised references to AMC E 650.

NPA 2014-03 provides a further description of the amendments originally proposed by the Agency. Two of the main points described in the NPA 2014-03 are summarised as follows:

##### Corrected speed

The highest values of corrected speed occur at altitude. Reproducing these Engine operating conditions at altitude, in sea level test conditions, requires elevated physical speeds. In general, this is achievable for compressors, but may be impractical for other assemblies or components. Nevertheless, a literal reading of the current rule is apt to lead to the conclusion that a sea level test requires shaft speeds in excess of what is practically achievable.

For some gas turbine components, there are more appropriate ways of meeting the rule's objective of avoiding flutter and other damaging aeromechanical phenomena.

Therefore, the prescriptive corrected speed requirement has been moved to the AMC. Correspondingly, more prominence is given within the rule to the objective requirement of CS-E 650(c)(2). The value of the corrected speed concept in the context of the vibration rule is not diminished, however the proposal restores the clarity of how to apply the concept of corrected speed.



### Validated analysis

The revision to the rule introduces the possibility of validated analysis as a means to extend the applicability of existing results from a so-called 'baseline test'. Fundamentally, the proposed rule still requires compliance by test. It has always been the case, though, that the complementary concepts of baseline test plus validated analysis may be accepted as equivalent to a new test. The more the configuration for which approval is sought differs from the configuration in the baseline test, the greater the dependence on analysis. The difficulty lies in deciding how much reliance may be placed on analysis, and this has been, and will always be, a matter requiring some judgment. For the vibration rule, it seems that such judgment is particularly difficult and may have resulted in a lack of standardisation in the past. This AMC sets some boundaries to support this process.

The new AMC also introduces the possibility of alternative ways to demonstrate the margins inherent in the requirement to test beyond 100 % speed.

Following the comments received, the Agency modified the text as described in 8.3. Additionally, some editorial changes have been made. The final text is provided in a separate Annex to this Decision.



## **9. References**

Non applicable.

### **9.1. Related regulations**

Non applicable.

### **9.2. Affected decisions**

Decision No 2003/009/RM of 24 October 2003.

### **9.3. Reference documents**

Non applicable.



## 10. Editorial changes

In addition to changes that resulted from the NPAs, this Amendment 4 of CS-E includes two editorial updates. The first editorial correction updates paragraph (5) 'Related documents' of AMC E 510; more specifically, the related SAE Document No ARP4754 has been updated to revision A. The title of this document has also been updated. The second editorial correction updates the title of CS-E 580 under 'CONTENTS (General lay-out)' to be in line with the title of CS-E 580 in Book 1.

