



Ageing aircraft structures

RELATED NPA/CRD 2013-07 — RMT.0225 (MDM.028)

EXECUTIVE SUMMARY

This Opinion addresses safety risks related to ageing phenomena in the structures of large aeroplanes. These risks include fatigue of the basic type design, widespread fatigue damage (WFD), corrosion, fatigue of changes and repairs, and continued operation with unsafe levels of fatigue cracking.

The proposal is intended to ensure that these safety risks are mitigated for both the existing and future fleets of large aeroplanes.

The opinion proposes to:

- (a) amend Regulation (EU) 2015/640 and to include new requirements in its Annex (Part-26 — ‘Additional airworthiness requirements for operations’);
- (b) amend Regulation (EU) No 748/2012, Annex I (Part-21) ‘Certification of aircraft and related products, parts and appliances, and of design and production organisations’;
- (c) amend Regulation (EU) No 1321/2014, Annex I (Part-M);

The proposal will ensure that Design Approval Holders (DAHs), or applicants for Type Certificates (TCs), Supplemental Type Certificates (STCs), design changes and repair approvals, will produce the necessary data, procedures, instructions and manuals related to ageing structure failures due to corrosion and fatigue and make them available to those who need to comply with them (operators).

Additionally, operators will be required to incorporate these data items into their maintenance programmes while addressing the adverse effects of changes and repairs on each airframe and its associated maintenance requirements.

The proposal is largely harmonised with the Federal Aviation Administration (FAA) requirements on this subject.

Action area	Design and maintenance improvements			
Affected rules	Part-21, Part-26, Part-M			
Affected stakeholders	Large aeroplane TC/RTC/STC holders; applicants for a TC/RTC/STC; design or repair approval; operators; maintenance organisations; competent authorities			
Driver	Safety	Reference	N/a	
Rulemaking group	Yes	Impact assessment	Full	Procedure Standard

● EASA rulemaking process

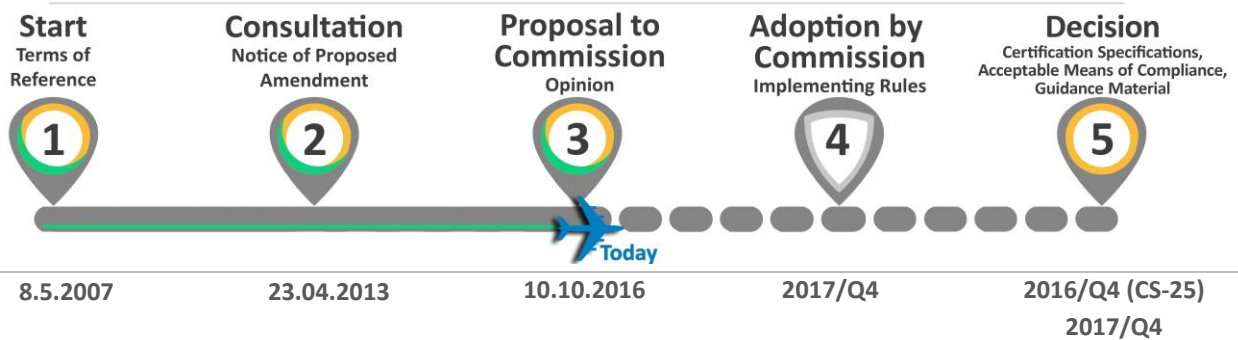


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1. Procedural information

1.1. The rule development procedure

The European Aviation Safety Agency (EASA) developed this Opinion in line with Regulation (EC) No 216/2008¹ (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure².

This rulemaking activity is included in EASA's [5-year Rulemaking Programme](#), under RMT.0225 (MDM.028(a)). The scope and timescale of the task were defined in the related terms of reference (ToR) (see the process map on the title page).

All interested parties were consulted through NPA 2013-07³. 674 comments were submitted by 48 interested parties, including (supplemental) type certificate holders ((S)TCHs), Civil Aviation Authorities, operators and others. EASA has addressed and responded to the comments received on the NPA.

In addition, a review group meeting has been held since the publication of NPA 2013-07.

As the consideration of the comments received during public and focused consultations resulted in a number of substantial changes to the text proposed by NPA 2013-07, EASA allowed further public consultation (reaction) on the proposed resulting text through CRD 2013-07, published on 27.07.2016.

Initially, EASA established a CRD reaction period of one month, however, further to stakeholders' requests, the reaction period has been extended by an additional month (to 26.09.2016).

EASA's responses to all comments received during the initial NPA consultation, as well as during the CRD reaction period, are presented in comment-response document (CRD) 2013-07 issue 2⁴.

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. The text of the draft rule proposed by EASA is annexed to this Opinion and published on EASA's website⁵.

1.3. The next steps in the procedure

This Opinion contains proposed changes to the following Regulations:

- Regulation (EU) 2015/640,

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

² EASA is bound to follow a structured rulemaking process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by EASA'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 In accordance with Article 52 of the Basic Regulation and Articles 6(3) and 7 of the Rulemaking Procedure.

⁴ <http://easa.europa.eu/document-library/comment-response-documents>

⁵ <https://www.easa.europa.eu/document-library/opinions>



- Regulation (EU) No 748/2012, and
- Annex I (Part-M) of Regulation (EU) No 1321/2014.

The Opinion is addressed to the European Commission, which will use it as a technical basis to prepare a legislative proposal.

The proposal will be complemented by an EASA Decision to amend CS 25.571 and the corresponding AMC 25.571, which will be published after this Opinion.

The Decision containing the related certification specifications (CSs), acceptable means of compliance (AMC) and guidance material (GM) to Part-26 and to Part-M will be issued by EASA when the related implementing rule(s) (IRs) are adopted by the Commission.

2. Explanatory Note

2.1. Issues to be addressed

General Introduction of the issue

Any aircraft could be considered to be ageing from the moment of its manufacture. The ageing of an aircraft depends on factors including its chronological age, the number of flight cycles, and the number of flight hours. Individual aircraft components age differently, and some of the ageing mechanisms are fatigue through repetitive cycles, wear, deterioration and corrosion. Since these factors will increase the pace and effects of the ageing process, they can be a significant safety concern if they are not properly understood and managed throughout the life of the aircraft.

Service experience has shown that there is a need to have continually updated knowledge of the structural integrity of aircraft, especially as they become older. The structural integrity of aircraft is of concern because factors such as fatigue cracking and corrosion are time and usage-dependent, and our knowledge about them can best be assessed based on real-time operational experience and the use of the most modern tools of analysis and testing.

Many aircraft accidents around the world have been linked to ageing aircraft.

Safety objectives for ageing aircraft structures

The 'ageing aircraft structure' rule is proposed with the objective of preventing the catastrophic failure of ageing large aeroplanes due to fatigue, including widespread fatigue damage (WFD), and corrosion.

Hereinafter, the main areas of risk addressed in the proposal are further described.

1) Fatigue

Fatigue occurs through the application of cyclic loading and is inevitable in the aluminium alloy materials predominantly used in the current world fleet. The link between loading cycles and fatigue initiation and crack growth establishes an obvious association between fatigue-related ageing and the number of flight cycles/hours accumulated by an aircraft.

2) Continued safe operation of aircraft structures without Damage Tolerance (DT) evaluations

The principle of DT is that although cracks may be initiated due to fatigue and may then subsequently propagate, the process can be understood and managed by inspection, repair and, on a case-by-case basis, a modification. Inspections based upon a DT philosophy are essential to



detect cracks before they can affect safety. Testing and analysis is used to determine inspectable defect sizes, crack growth rates, critical crack lengths and the associated residual strength to determine inspection thresholds and intervals.

3) Corrosion

Corrosion in airframes is usually in the form of an electrochemical oxidation of the metal alloy. It is more prevalent in marine and coastal environments due to the high humidity and exposure to salt. Corrosion weakens the material, both reducing the effective cross section and creating locations of stress concentration. To slow down the corrosion rate, careful material selection, surface coatings and other design considerations such as effective drainage are employed. Corrosion combined with fatigue is of the greatest concern.

4) Widespread Fatigue Damage (WFD)

WFD in a structure is characterised by fatigue damage originating cracks at multiple locations of size and density, to the extent that the structure no longer maintains its required residual strength. The traditional application of damage tolerance analysis from a single or dual crack origin is not sufficient to preclude WFD. Fatigue cracks related to WFD can grow quickly and interact in such a way that an operator cannot inspect the susceptible structures effectively or often enough to ensure the detection of the cracks before they lead to a structural failure. A separate WFD assessment and the determination of specific maintenance actions are necessary to address WFD adequately.

To preclude WFD, operation of an aircraft should not be allowed beyond a certain point in the life of the airframe, known as the Limit of Validity (LOV) of the structural maintenance programme.

The LoV is the period of time, stated as a number of total accumulated flight cycles or flight hours or both, for which it has been demonstrated that WFD is unlikely to occur in the aircraft structure. The inspections and other maintenance actions and procedures resulting from this demonstration shall be sufficient to prevent catastrophic failure of the aircraft structure.

Since there are still aircraft that were designed, modified or repaired without robustly addressing some of the aforementioned principles, the proposed ageing aircraft rule will impose new requirements for the current fleet and will include improved requirements for future aircraft designs.

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.

The proposal is intended to ensure that these safety risks are mitigated for turbine-powered large aeroplanes certified after 1 January 1958.

To mitigate the aforementioned risks, this proposal introduces additional airworthiness specifications for operators in order to support the continuing airworthiness and safety improvements of:

- (a) aircraft registered in a Member State;



- (b) aircraft registered in a third country and used by an operator for which a Member State ensures oversight;

This proposal also lays down additional airworthiness specifications for the design approval holders of aircraft type designs, changes and repairs approved by EASA or deemed to have been issued in accordance with Commission Regulation (EU) No 748/2012.

The specific objective of this proposal is, therefore, to:

- a) Amend Part-26 in order to address the issue of ageing aircraft structure for the current fleet and improve the requirements for future aircraft designs, noting that similar provisions to address ageing aircraft safety exist within the US rules for continued airworthiness and safety improvements for large aeroplanes.
- b) Update Part-21 with the necessary references to Part-26 in order to ensure that TCHs (type certificate holders) and STCHs (supplementary type certificate holders) address the effects of ageing aircraft structures as part of the approval of type certificates, changes and repairs.
- c) Update Part-M with the necessary reference to Part 26 in order to ensure that operators address in their maintenance programmes the effects of ageing aircraft structures.

2.3. Outcome of the consultation

674 comments were submitted by 48 stakeholders during the NPA 2013-07 consultation.

The stakeholders commenting on NPA 2013-07 included authorities (e.g. the FAA, CAA-UK), (supplemental) type certificate holders ((S)TCHs), operators and others.

The comments were mainly addressing elements that were not harmonised with the corresponding FAA rule, in addition to concerns regarding the criteria to exclude certain aircraft, modifications and repairs from Part-26, and consistency with the similar provisions of other Authorities.

For additional details and individual responses to comments, please see CRD 2013-07 issue 2.

Several comments were accepted or partially accepted, thus leading to substantial amendments of the proposed ageing aircraft requirements and significantly improved harmonisation with the corresponding FAA requirements.

Nonetheless, due to the substantial changes, EASA offered an additional public consultation through CRD 2013-07.

The additional public consultation (reaction period) of CRD 2013-07 resulted in 47 reactions submitted by six stakeholders.

As already observed during the consultation carried out on NPA 2013-07, the majority of reactions referred to Part-26.

These reactions led to some specific improvements of the text of the rule and will be accounted for in the decisions to follow.

For additional details to these reactions, please refer to CRD 2013-07 issue 2.

2.4. Summary of the Regulatory Impact Assessment

The RIA published in NPA 2013-07 compared the following two options:



Option 0	Do nothing. Voluntary compliance (through the existing AMC 20-20). Allow the industry to develop its own structural integrity programmes under EASA's guidance.
Option 1	Provide mandatory requirements. Develop requirements for ageing aircraft structures for the existing fleet and for the future fleet.

Many comments to the initial impact assessment (NPA 2013-07) were related to the cost of non-harmonisation with the FAA requirements for ageing aircraft. Taking into account these comments and supported by the rulemaking review group (RMT.0225), EASA has focused on aligning the rule with the FAA rules where possible, therefore minimising the cost impact of non-harmonised elements of the rule.

Taking into account the comments provided during the NPA 2013-07 consultation, EASA re-drafted the rules focusing on safety, cost efficiency, and harmonisation with the FAA.

As an additional step, to further benchmark the re-drafted rules, EASA has allowed for a public reaction period, following the publication of the CRD 2013-07. Only a limited number of comments related to the re-drafted Part 26 rules have been received within this reaction period, which validates the steps taken by the EASA to reduce the cost of non-harmonised elements.

The following main concerns from the initial consultation period are identified and have been addressed as follows:

a) *Acceptance of approved data, which satisfied the FAA requirement on ageing aircraft, to comply with Part 26 requirements for ageing aircraft*

EASA intends to accept largely the existing data provided in compliance with similar requirements from other authorities (e.g. with FAA under 14 CFR Part-26). This acceptance will limit the cost burden on design approval holders that already have shown compliance to the FAA's ageing aircraft requirements. EASA will provide further assistance regarding this topic during the implementation phase of the Part 26 requirements (e.g. workshops to explain to stakeholders when and how they can use these data)

b) *Requirement for damage tolerance inspections (DTIs) and corrosion prevention and control programmes (CPCP) for large aeroplanes below 7 500 Lbs of payload or 30 passengers which is not required by the FAA requirements for ageing aircraft*

The rule has been redrafted such that it is not required for large aeroplanes below 7 500 Lbs of payload or 30 passengers to develop DTIs, in order to be harmonised with the FAA. The requirement to develop a corrosion prevention and control programme, is however retained. The FAA does not require a CPCP in 14 CFR Part 26 but recognises the need for having something in place to address the corrosion issue (e.g. existing CPCPs have been mandated by the FAA). The requirement for a CPCP, for all large aeroplanes under Part 26, ensure a level playing field and a consistent availability of a baseline CPCP to operators. This is more efficient for EASA as it does not have to manage the CPCP using individual Airworthiness Directives. The cost impact for the large aeroplane manufacturers is considered limited as many TC Holders have already CPCP's in place using the MSG-3 process.



- c) *No clear provisions to exclude certain aircraft from the Part 26 applicability similar to the exemption process used by the FAA for the ageing aircraft rules.*

The rule has been re-drafted to allow DAHs to identify if an additional application limit applies to their aeroplane, modification or repair based on specific conditions defined by EASA (taking into account risk and proportionality). If it is determined that the additional application limitation applies, no compliance to the ageing aircraft rules, or parts thereof, have to be demonstrated (EASA needs to be informed about these limitations). This approach provides additional reductions in cost burden for DAHs as well a limited administrative burden for EASA.

- d) *Implementation of a process to ensure the continuing structural integrity programme remains valid throughout the life of the aircraft*

The details of the rule and guidance material requiring such a process have been extensively modified in response to the comments received. In particular, the elements related to the monitoring of fleet usage at rule level have been deleted. Although no directly similar FAA requirement exists, in the past, there have been mandatory modification programmes and current implementation of continued operational safety programmes by FAA may partially satisfy the intent of this rule. EASA expects that most TCHs have already procedures in place that satisfy the requirement to have such a process. The proactive rule reduces the burden on the TCHs as well as on EASA for responding to in-service events that lead to mandatory corrective actions.

- e) *Difference with the FAA regarding the definition of the limit of validity (LOV) of the structural maintenance programme.*

In order to avoid potential additional costs for European operators compared to their US competitors, it was decided to fully harmonise the definition of the Limit of Validity with the LOV definition used by the FAA. In addition, the required actions to extend an LOV are harmonised with the FAA as well. The additional modifications and inspections which the TC Holders need to develop to support the LOV are to a large extent already developed because of similar existing FAA requirements for ageing aircraft. Therefore, the additional costs for the TCHs to develop an LOV and supporting modifications and inspections are expected to be minimal.

- f) *Lack of flexibility for operators regarding means to address the adverse effects repairs and modifications may have on fatigue critical aircraft structure*

The first rule proposal did not allow the operators to have flexibility regarding the means they could use to address the adverse effects that repairs and modifications existing in their fleet would have on fatigue critical structure. The redrafted proposal allows operators to use other means (i.e. inspections and other procedures) than those promulgated by the DAHs under the ageing aircraft rule. The flexibility avoids unnecessary costs (such as cost of grounding aircraft due to non-compliance) in case certain DAHs would have issues to comply with the ageing aircraft rules. In general, the operators will benefit from the implementation of maintenance actions and the LOV of their maintenance programme to address the effect of ageing aircraft structure, as it reduces the risk of incidents and accidents. The ageing aircraft rules will also provide potential for extension of the economic life of the aircraft by reducing the need for costly repairs due to cracking of ageing aircraft structure.

- g) *Burden on STC holders to develop DTI for certain STCs*



Following the redrafting of the rule, and because of *historical reasons related to record keeping before the entry into force of Part 21, some STCs holders will not be required to develop DTI unless operators request the DTI. This reduces the risk of unnecessary costs to develop DTIs for STC that are installed on aircraft for which the operator is not subject the ageing aircraft rule.*

Taking into account the RIA conducted for the NPA as well as the concerns addressed in the consultation phase of the NPA, the following considerations are provided for option 0 and option 1:

Option 0	The actual impacts would depend on how many of the affected stakeholders chose to implement the principles of AMC 20-20 for their existing fleets. The implementation of the AMC 20-20 would not ensure consistent application to the fleets.
Option 1	<p>This option would provide a framework to address proactively issues regarding ageing aircraft safety.</p> <p>This option will reduce the risk, in a consistent way across the fleets, of having an incident or accident due to ageing aircraft structure phenomena.</p> <p>This option may also contribute to significantly reducing the downtime associated with urgent unscheduled maintenance, including the cost of complex repairs, or the cost of implementing Airworthiness Directives related with ageing aircraft issues.</p> <p>Further, this option allows to have harmonised requirements (i.e. to a large extend) for ageing aircraft with the FAA which fosters the level playing field between US and EU stakeholders (i.e. DAHs and operators).</p> <p>Potential cost would be relevant for operators and DAHs who have not implemented AMC 20-20 from Option 0.</p> <p>However, the additional costs are minimised due to following: Most of the European DAHs have already shown compliance to the FAA requirements for Ageing Aircraft for which a benefit can be taken. The overall operator's cost to review repairs and modifications, to obtain DTI, and to implement the LOV and associated maintenance inspections, are limited due to the fact that these measures are offset by the cost of potential incidents/accidents or long downtimes and costly repairs due to ageing aircraft issues. In addition, an LOV and associated maintenance actions may increase the economic life the aircraft bringing additional benefits to those operators wishing to operate their aircraft as long as possible. Flexibility has been provided to DAHs who wish not to comply with the requirements based on specific conditions defined by EASA. The cost of some non-harmonised elements with the FAA are mostly limited to the need of having a CACP for some large aeroplanes and the need to develop a process to ensure the continued validity of the structural integrity</p>



	programmes. For both cases it is believed the most affected TCHs do have elements already in place to comply with the proposed regulation.
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After having taken into account the comments received during the consultation process, the Option 1 of the RIA proposes safe and cost-efficient rules. It is the preferred option.

2.5. Overview of the proposed amendments

The proposed amendments to Regulation (EU) 2015/640 and its Annex I (Part-26) are:

- Article 1 ‘Scope’: the scope has been extended to Design Approval Holders of Type Designs, Changes and Repairs
- Article 2 ‘Definitions’: new definitions have been added
- Article 3 ‘Additional Airworthiness Specifications for a given type of operation’: the applicability has been extended to Design Approval Holders of aircraft, Changes and Repairs
- 26.10 ‘Competent Authority’: EASA has been added as the competent authority
- 26.30 ‘Demonstration of Compliance’: Design Approval Holders of Type Designs, Changes and Repairs have been added

The following new paragraphs were added in Subpart B (Large aeroplanes)

- 26.300 Continuing structural integrity for ageing aircraft structures — general requirements
- 26.310 WFD evaluation of type design changes
- 26.320 Damage tolerance data for existing repairs and existing changes to fatigue-critical structure
- 26.330 Damage tolerance data for existing STCs, other existing major changes and existing repairs affecting those changes or STCs
- 26.350 Extension of an LOV
- 26.360 Fatigue and damage tolerance evaluation of future repairs and changes
- 26.370 Continuing airworthiness tasks and aircraft maintenance programmes
- 26.380 Additional limitations

The proposed amendments to Regulation (EU) No 748/2012 and its Annex I (Part-21) are:

The following articles and points have been amended to refer to Part-26:

- Article 1 ‘Scope and definitions’:
- 21.A.21 Requirements for the issuance of a type-certificate or restricted type-certificate
- 21.A.61 Instructions for continued airworthiness
- 21.A.101 Type-certification basis, operational suitability data certification basis and environmental protection requirements for a major change to a type-certificate
- 21.A.120 Instructions for continued airworthiness
- 21.A.433 Requirements for approval of a repair design



The proposed amendment to Annex I (Part-M) of Regulation (EU) No 1321/2014 is:

- M.A.302 Aircraft Maintenance Programme has been amended to refer to Part-26

Done at Cologne, on 7 October 2016

Patrick Ky
Executive Director



3. References

3.1. Affected regulations

- Commission Regulation (EU) No 748/2012 on implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations
- Commission Regulation (EU) 2015/640 on additional airworthiness requirements for operations
- Commission Regulation (EU) No 1321/2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks

3.2. Affected decisions

- Decision 2015/013/R of the Executive Director of the European Aviation Safety Agency on additional airworthiness specifications for operations ('CS-26')
- Decision 2016/010/R of the Executive Director of the European Aviation Safety Agency of 22 June 2016 on Certification Specifications, including airworthiness codes and Acceptable Means of Compliance, for large aeroplanes ('CS-25')
- Decision 2003/012/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on Acceptable Means of Compliance for airworthiness of products, parts and appliances ('AMC-20')

3.3. Reference documents

N/A

