EASA	CERTIFICATION MEMORANDUM
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Subject

Engine Critical Parts - Damage Tolerance Assessment

Manufacturing and Surface Induced Anomalies

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Log of Issues

Issue	Issue date	Change description
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Table of Contents

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The purpose of **this** Certification Memorandum is to provide specific guidance for applicants when demonstrating compliance with CS-E 515 (a) which requires that "appropriate Damage Tolerance assessments must be performed to address the potential for Failure from material, manufacturing and service-induced anomalies within the Approved Life of the part", when establishing the engineering Plan.

This Certification Memorandum describes how to complement the AMC to CS-E 515, with the intention of establishing a consistent level of response in addressing surface damage tolerance in critical rotating parts.

Damage tolerance for material sub-surface anomalies is not considered in this Certification Memorandum.. These measures are required to be identified in an Engineering Plan and a Manufacturing Plan as per CS-E 515 (a) and (b).

1.2. REFERENCES

It is intended that the following reference materials be used in conjunction with this Certification Memorandum:

Reference	Title	Code	Issue	Date
CS-E 515	Engine Critical Parts	CS-E	---	
FAA AC 33.70-1	Guidance Material for Aircraft Engine Life-Limited Parts Requirements	FAA Part 33	---	31/07/2009
FAA AC 33.70-2	Damage Tolerance of Hole Features in High-Energy Turbine Engine Rotors	FAA Part 33	---	28/08/2009

1.3. ABBREVIATIONS

The following abbreviations are used in this Certification Memorandum:

Abbreviation	Meaning
CM	**C**ertification **M**emorandum
AMC	**A**cceptable **M**eans of **C**ompliance
CS	**C**ertification **S**pecification
CRI	**C**ertification **R**eview **I**tem
EASA	**E**uropean **A**viation **S**afety **A**gency
FAA	**F**ederal **A**viation **A**dministration
AC	**A**dvisory **C**ircular
ICA	**I**nstructions for **C**ontinued **A**irworthiness

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1.4. DEFINITIONS

The following definitions are used in this Certification Memorandum:

Definition	Meaning
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2. BACKGROUND

The need for Surface Damage Tolerance assessment has arisen due to the increasing optimisation of designs which has tended to erode the margin which has been relied upon to ensure damage tolerance in the past, and the introduction of materials which are inherently less tolerant to such damage. The lack of industry data on actual service anomalies however presents a significant problem in assessing the required level of damage tolerance. A policy is therefore required to achieve a consistent standard of compliance.

The certification policy defined in this Certification Memorandum represents an interim approach to addressing the problem of surface anomalies in the absence of industry wide anomaly size and frequency distribution data. The objective is to ensure that a defined level of damage tolerance for entry into service is met and also to initiate a service management review process.

3. EASA CERTIFICATION POLICY

3.1. EASA POLICY

In order to demonstrate compliance with CS-E 515, a damage tolerance assessment is required. This EASA policy addresses surface damage tolerance in critical rotating parts and the compliance approach outlined is in two aspects:

- Firstly a minimum level of damage tolerance capability should be established for each critical component using a deterministic approach based on a defined maximum defect size.
- Secondly, a service damage monitoring process should be established in order to gain assurance that service damage is consistent with serviceable and repairable limits and to initiate appropriate corrective action if damage is found outside these established limits.

In addition, an alternative probabilistic compliance approach may be presented based on adequate data and processes agreed between the applicant and the Agency.

At the time of issuance of this Certification Memorandum, FAA has issued AC 33.70-2 (dated 28 August 2009) which provides a damage tolerance approach to address manufacturing and operationally-induced anomalies in turbine engine rotating part hole features, using the Probabilistic Damage Tolerance Risk Assessments (PDTRA) methodology outlined in AC 33.70-1. Where the Type Certificate Holder has demonstrated that they achieve the objectives of FAA AC 33.70-2, the applicant would not need to consider this Certification Memorandum for those features addressed by the AC.

If further to issuance of this Certification Memorandum additional industry developed feature based methodologies become available, then these will be considered by the Agency.

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If adequate data is not available, the following criteria and considerations should be considered when demonstrating compliance with CS-E 515:

A. Deterministic Approach:

A1. Deterministic Damage Tolerance Assessment

Demonstrate that the Surface Fracture Mechanics Life for all critical parts exceeds 3,000 cycles or 50 percent of the part certified life, whichever is less.

Assumptions:

(a) Analyses performed using Linear Elastic Fracture Mechanics;

(b) Initial anomaly size is one of the following:

- 0.762mm x 0.381mm (0.030 inches x 0.015 inches) for an assumed (semicircular) surface anomaly.
- 0.381mm x 0.381mm (0.015 inches x 0.015 inches) for an assumed (quarter-circular) corner anomaly.

(c) The assumptions used in this analysis (i.e. material properties, reference engine cycle, operating environment and its effect on the stress cycle etc.) should be declared.

(d) Anomalies should be treated as sharp propagating cracks from the first stress cycle.

A2. Service Damage Monitoring

The overall objective of Service Damage Monitoring is to review data obtained from field operation of the Type Design engine to determine if there are anomalous conditions which require corrective action. Appropriate action(s) may include assessment of the impact of damage observed on one part/location on other parts/locations.

Applicants should determine if surface damage that has been detected is consistent with the serviceable and repairable limits and determine if additional actions are required to prevent failure and rectify any potential unsafe condition which may be identified. Service damage monitoring consists of the following:

1. Determine the serviceable and repairable surface damage limits using a process approved by the Agency and summarized within the service management plan. Damage size limits should be a function of part, part location, and damage type. Damage should include, but may not be limited to, nicks, dents, scratches and cracks. The serviceable and repairable limits should be published in the ICA.

2. Establish a monitoring process to record damage that meets all of the following criteria:
   - is inconsistent with or exceeds the repairable limits;
   - is made available to the Type Certificate Holder (TCH) or Supplemental Type Certificate Holder (STCH) through existing reporting channels;

   Document the monitoring process in the service management plan. This activity should record at a minimum the damage size, type and location observed during service inspections for each Critical part.

3. Assess damage meeting the criteria defined in 2 above. This assessment should consider:
   - the impact of the observed damage on the life of the damaged part
   - the likelihood for recurrence of similar damage
   - whether the damage has been determined as having flown
   - whether the damage is likely to escape to the field

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- recommended corrective actions to identify/prevent/eliminate the source of the damage

During the service life of the part, a summary of the damage information obtained by the damage monitoring process, as well as the corrective actions implemented, should be made available to the authorities during continued airworthiness discussions. The actions identified herein do not alter or affect the requirements of paragraph 21.A.3 of Annex Part 21 to Commission Regulation (EU) N° 748/2012 of 3 August 2012.

B. Probabilistic Approach

B1. Probabilistic Damage Tolerance Assessment

If an applicant chooses to pursue a probabilistic alternative to the deterministic approach detailed in paragraph 3.1.A. above, the applicant should provide and agree with the Agency such data that have an impact on the risk levels resulting from the analysis. These may include but are not limited to the following items as appropriate to the component:

- Anomaly size / frequency distribution
- Fleet utilisation
- Maintenance practices
- Production / Assembly processes
- Anomaly growth characteristics
- Inspection techniques and intervals
- Inspection Probability Of Detection (POD)

The process utilised to carry out the analysis needs to be agreed with the Agency.

The probabilities of Hazardous Engine Effects that must be met are defined in CS-E 510 (a) (3).

Note: When referring to CS-E 510(a)(3) an individual failure is considered to be a failure occurring anywhere in the engine as a result of a damage tolerance related cause and is not related to the failure of an individual component.

B2. Service Damage Monitoring

As per paragraph 3A2. above.

B3. Additional Requirements

The applicant should demonstrate that adequate processes are in place in order to validate the assumptions utilised in the analysis and discussed in paragraph 3.1.B1. above. These assumptions need to be validated throughout the life of the certified product.

Any departure from the original assumptions will require the applicant to repeat the analysis as per paragraph 3.1.B1. above and communicate the results thereof to the Agency.

If the revised analysis shows that the safety objectives of CS-E 510 (a) (3) can no longer be met, then corrective action must be implemented in accordance with paragraph 21.A.3 of Annex Part 21 to Commission Regulation (EC) N° 748/2012 of 3 August 2012.

3.2. WHO THIS CERTIFICATION MEMORANDUM AFFECTS

Applicants for an engine Type Certificate that need to show compliance with CS-E 515.

Applicants for a change to an engine Type Certificate when this change affects compliance with CS-E 515.

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4. REMARKS

1. Suggestions for amendment(s) to this EASA Certification Memorandum should be referred to the Certification Policy and Planning Department, Certification Directorate, EASA. E-mail CM@easa.europa.eu or fax +49 (0)221 89990 4459.
2. For any question concerning the technical content of this EASA Certification Memorandum, please contact:

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