



## FUTURE REPAIR AND MAINTENANCE FOR AEROSPACE INDUSTRY

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**Conceptual design of the new certification  
processes**

Final version

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Short description		<p><i>This document deals with the conceptual design of the new certification processes for AM implementation into the manufacturing and repairing of an aircraft component.</i></p> <p><i>Concepts and workflows for complete parts and repaired parts are defined; and new certification frameworks and specific procedures for the different operations/strategies in the RepAIR process - based on direct manufacturing of identified geometries - are developed and described among the document.</i></p> <p><i>It is included also the definition of the structure for a library of spare parts and build conditions compliant with the certification requirements.</i></p>		
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## Executive summary

This document deals with the conceptual design of the new certification processes for AM implementation into the manufacturing and repairing of an aircraft component.

Concepts and workflows for complete parts and repaired parts are defined; and new certification frameworks and specific procedures for the different operations/strategies in the RepAIR process - based on direct manufacturing of identified geometries - are developed and described among the document.

It is included also the definition of the structure for a library of spare parts and build conditions compliant with the certification requirements. All concepts developed have been applied to two specific demonstrators defined by end users.

In order to reach the scope of this document, it is divided into different chapters with legal information, current approval procedures for manufacturing and repairing components of an aircraft, development of a new certification process for AM implementation, new RepAIR strategies and all information that must be recorded in the certification component of RepAIR IT platform.

Any change of an aeronautical product (airplane, engine or propeller) has to be made in accordance with the regulations issued by European Aviation Safety Agency (EASA). The RepAIR project works on a new MRO concept based on the main advantages of IVHM and AM technologies. Introducing AM for manufacture, repair, or even redesign an aerospace part will affect the corresponding certification process. From this perspective, the first step is to identify how it will affect the Type Certificate (TC) of the correspondent product. These aspects will be discussed for the study cases in chapter 3.

Before dealing with EASA regulation, it is worth considering the Certification Specifications (CS) requirements, which are its basis. Considering that the “bracket” study case is a structural part of a Boeing airplane, the CS-25 have been studied and analysed to find the relevant points that affect directly to AM technology (chapter 4).

In RepAIR project, one of the study cases is about a new repair design for an engine component, the CFM56 -2/3 HPT Shroud. Subpart M of Part 21 prescribes procedural requirements for the approval of repairs made on products, parts, and appliances. The certification process to approve a new major repair design will be presented in chapter 5.

The analysis of the legal aspects applied in the project is the basis for the certification component development. A simplified overview of repairing an aircraft component has been followed for researching about the use of AM technologies in the aircraft market. On the other hand, it allows to collect all data and parameters that are essential to be stored in the databases that belong to the certification component (Chapter 6).

After the evaluation of all applied legal aspects and the difficulties to include AM technologies in the aircraft sector, the efforts have been concentrated in the definition of new strategies surroundings AM manufacturing and repairing parts. A new Process Qualification Procedure has been defined where all critical parameters are being detected, the key factors of all the supply chain have been defined and the allowance

range of them is identified in order to have a carefully control of the final AM parts. A set of studies has been defined to complete this Process Qualification procedure (Chapter 7).

All identified key factors, the legal aspects to be considered and the procedures have been classified and recorded in two different database structures. On the one hand, a library parts and build conditions database that contains all data and information of a part. On the other hand, a RepAIR Strategies-knowledge database that contains all procedures to be followed to obtain a part that meets the desired requirements. (Chapter 8)

Finally, all mentioned efforts have been used in two demonstrators defined by the end users of this project (Chapter 9).

Key achievements:

- The definition of a legal framework roadmap following the guidelines provided by EASA for introducing new design, manufacturing and repairing methods/techniques in an aircraft component has been established.
- The application of this legal framework roadmap applied to the RepAIR case studies: Boeing's Bracket and the HPT Shroud.
- A library part and build conditions database, which contains the information among the manufacturing/repairing process considering additive manufacturing (AM) and conventional manufacturing (CM) has been developed for implementing in the RepAIR IT platform.
- RepAIR strategies knowledge database, which contains the information among the manufacturing/repairing process considering additive manufacturing and conventional manufacturing has been developed for implementing in the RepAIR IT platform.
- A process qualification for implementing the AM in combination with CM into the manufacturing and repairing of an aircraft component has been developed.
- The defined process qualification procedure has been applied to the RepAIR case studies considered.