Metallic Duct Fitting

using Additive Manufacturing

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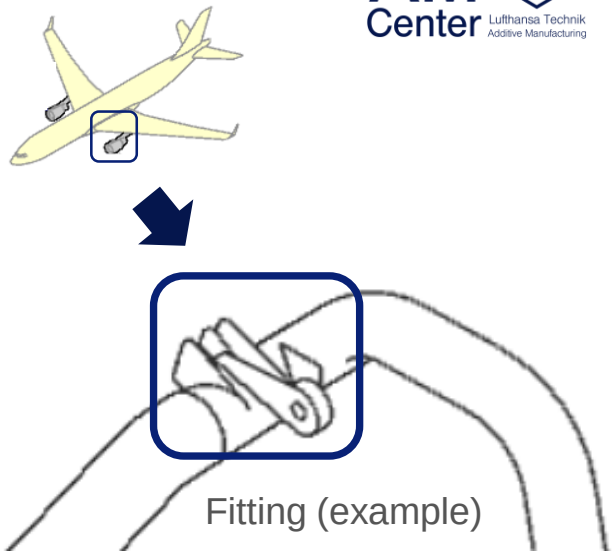
Lufthansa Technik

Duct Fitting (generic)

Part Description

- The **considered fitting** is part of the **engine bleed system**
- It connects the **bleed air tube** to the **airframe**
- Affected tube leads the **hot bleed air** of the engine to supply hot air **for anti icing** function
- It is located in a **non-pressurized area**



Dimensions and Weight
(approx.)

- **100mm x 50m x 10mm**
- **< 500 gram**

Duct Fitting

Safety Assessment

Secondary or Primary Structure

Acc. Structural Classification

Expected Loads

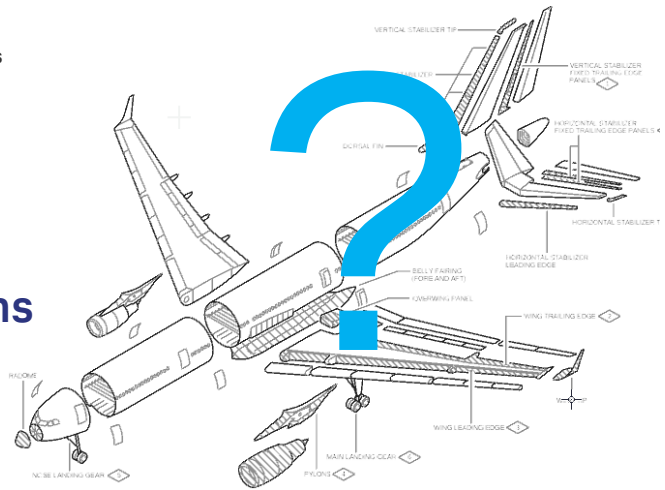
Maximum Flight loads, Emergency Landing Loads

Possible Part Failures

Wear ,tear, elongation, cracks ..

Worst Failure Scenario

Crack, looseness, loss … When? (Flight Phase)



Failure Affect on the System

No effect , limited, total system loss .. .

Effects on related Systems

E.g. due to loose remains of damaged part

Effect on Engine Level

CS-E 510 - Safety Analysis, a safe engine shut down is considered as minor safety effect on engine level

Failure Detection

Regular inspection, threshold, location …

Impact on the Flight Operation

Impact on aircraft operation, crew or passengers

Resulting Effect on Aircraft Level

CS-25.1309 Equipment, systems and installations.
Can differ to effect on Engine Level, e.g. depending on number of engines

Different Failure Mode due to AM ?

Failures because of new manufacturing method, material or design

Duct Fitting

LHT Design Classification Guideline

Consequence of failure

Structural function of AM part	No Safety effect	Minor	Major	Hazardous/ Catastrophic
Principle structural elements or fatigue critical				
Significantly loaded secondary structure parts				
Novelty (cavities, bionic-design optimization, novel application, new materials)				
Low loaded secondary structure parts				
Non loaded/decorative parts >500 gram				
Non loaded/decorative parts < 500 gram				

Duct Fitting

Requirements acc. Classification Guideline

Criticality: *No / low* → *high*

Material / Feedstock

Industry standard or specific, well-known commercially available

Fully controlled by 21/G

Production Process Definition

Required properties as defined (e.g. flammability, geometry, strength etc.)

Required properties defined by 21/J
Production Process fully controlled by 21/G

Certification Qualification

As required on part and installation level

Point or detail testing required only

Production Quality Control

As required to assure defined and required quality level

Limited, e.g. geometry, post-production only, further in-production inspections to be defined by 21/G

Precise definition of quality and quality control is required by 21/J

Approval and quality checks defined by 21/J. Changes approved by 21/J

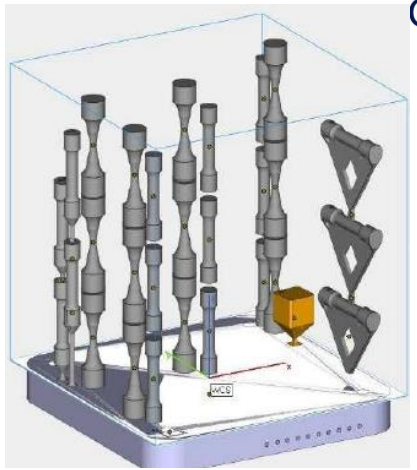
Extensive testing required (qualification pyramid)
Robust design values and verified processes available

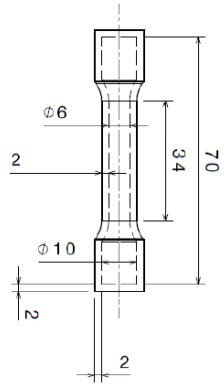
Intensive / high level of in/post production inspection to be defined by 21/J

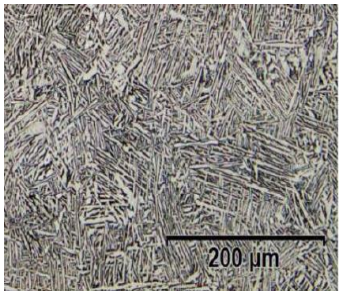
Duct Fitting

Resulting Qualification Program

- (FEM) Analysis performed in order to find the occurring loads and most loaded areas
- Material Specification and Material Qualification available. Provided by 21/G and verified by 21/J
- Part Qualification Program carried out. Three qualification builds performed. Build jobs include parts and specimens
- Test for tensile strength, fatigue and hardness performed
- Part Inspection by FPI and X-Ray
- Parts have been cut and microstructure analyzed
- Destructive test of additive manufactured part to compare results with original design







- ➢ Part Qualification program confirmed the material specification properties
- ➢ Constant quality (porosity and hardness) over the whole part

Thank you for your attention!

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