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## **Introduction of AM for AIRBUS products**

EASA Workshop  
Additive Manufacturing

29 September 2016  
Cologne



# Content

-  Approach to introduce Additive Manufacturing
-  Qualification approach
-  Regulations
-  Points of specific attention
-  Conclusion

# Approach to introduce Additive Manufacturing

- AIRBUS Group introducing Additive Manufacturing (AM) Parts on aeroplanes, helicopters and spacecraft.
- Intense Research work → Polyamide qualified, metallic applications ongoing.
- Presentation focused on Titanium Ti6Al4V Powder Bed Laser Beam and Electron Beam.

**Reduce lead time**

**Manufacture tooling**

**Reduce number of Parts and assembly phases**

**Complex geometry**

**Spare Parts**

**Reduce cost**

**Reduce Weight**

**Demonstrators and Prototypes**

**Integrate Functions**

**Topology optimised**

# Approach to introduce Additive Manufacturing

Intensive R&T work to characterise material (Ti6Al4V) and understand process parameters

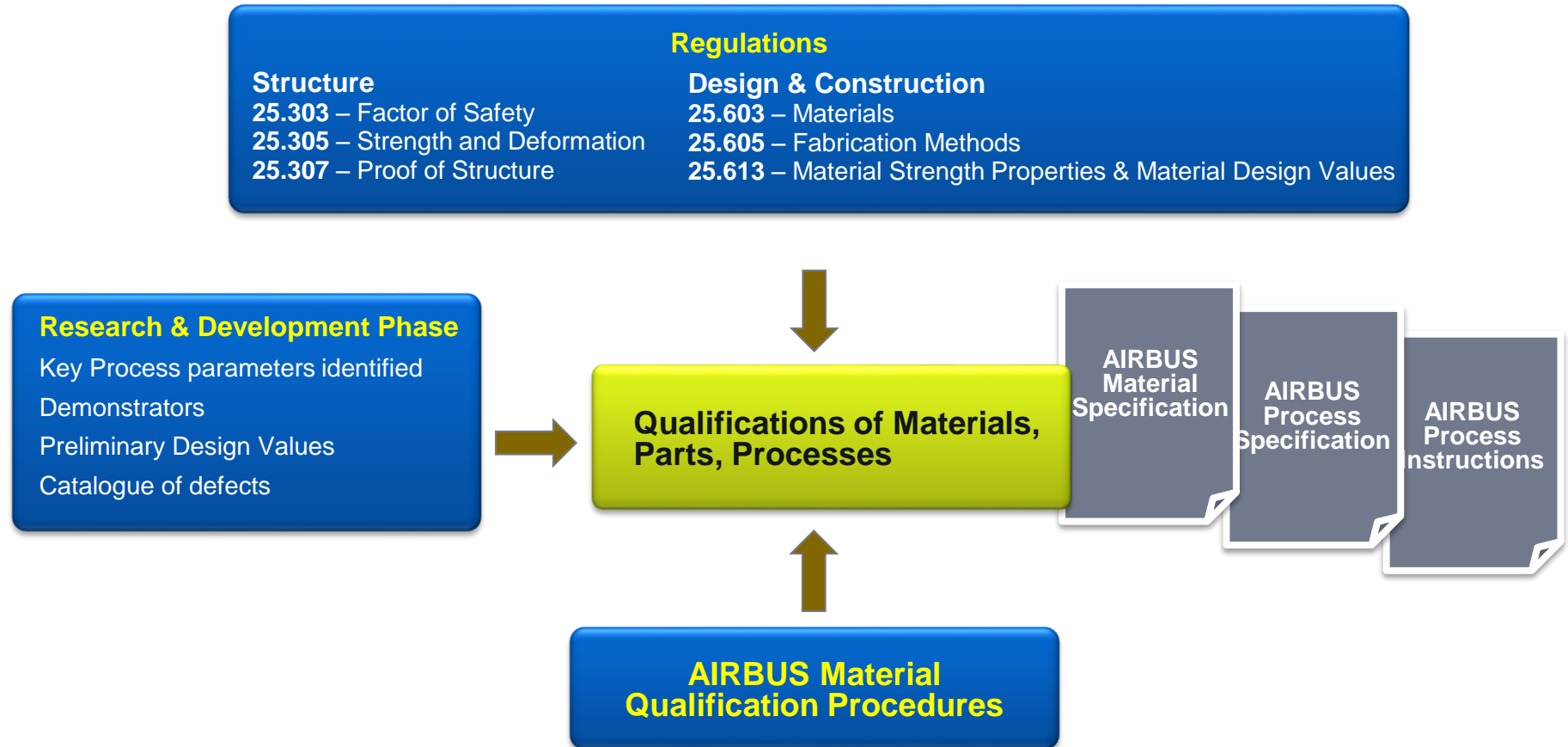
Tests	PB-EB / PB-LB	HIP / No HIP	Different machines	Effects of defects	Surface finish	Powders
<b>STATIC</b>						
Tensile						
Shear						
Compression						
Bearing						
<b>FATIGUE</b>						
Fatigue T-type (Kt 2.3)						
Fatigue Cyl.or plates (Kt 1)						
Fatigue Kt 5						
Fatigue High Load Transfer						
<b>DAMAGE TOLERANCE</b>						
Crack Growth C.A. ≠ R-ratio						
Crack Growth Spectrum						
Fracture toughness (CT)						

>1600 coupon tests

Demonstrators already flying on flight test aircraft

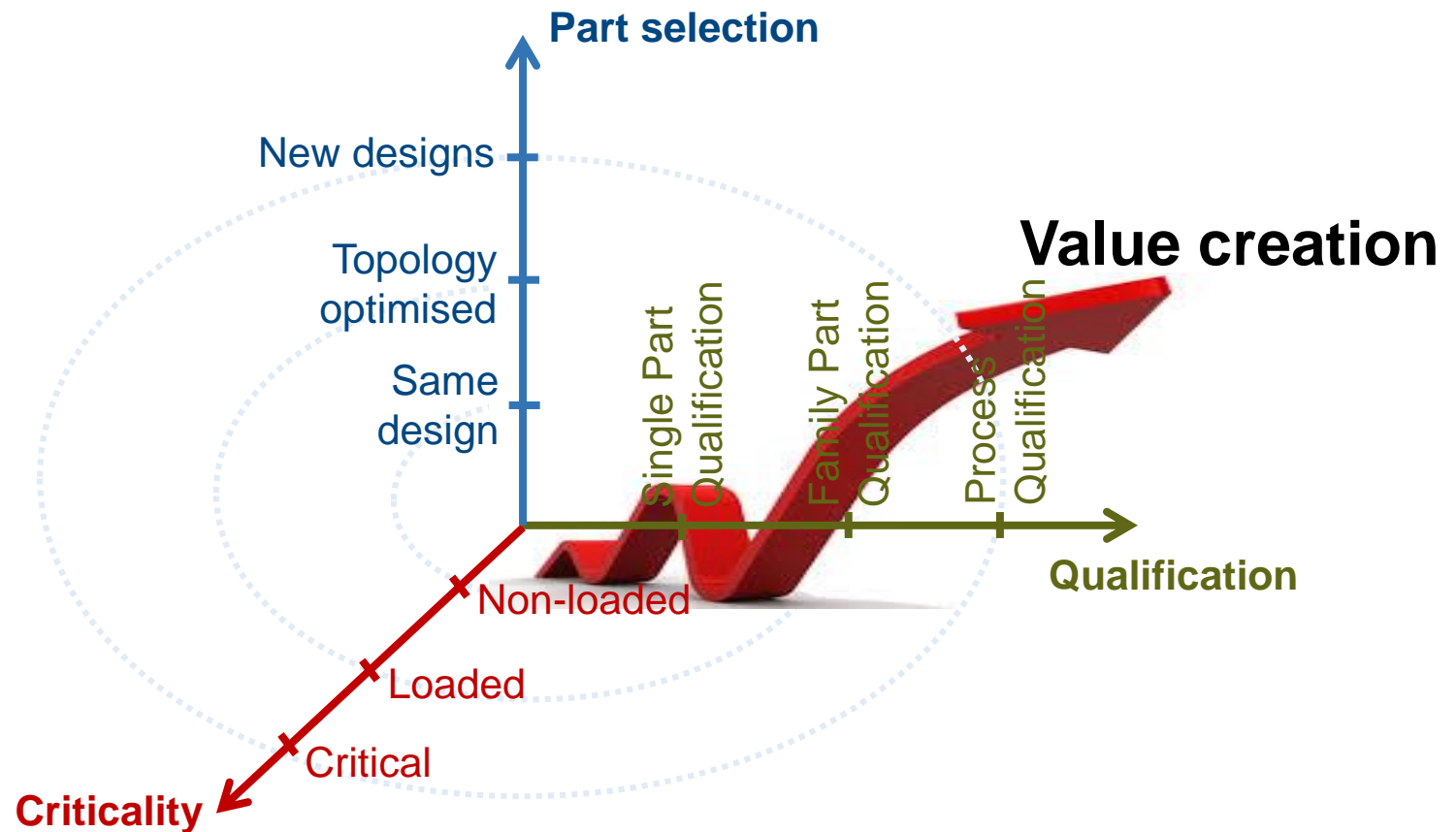


# Approach to introduce Additive Manufacturing



Approach applied to introduce any new material or technology (e.g. Glare, Welding).

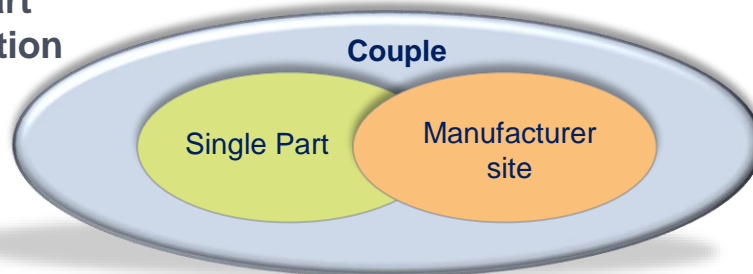
# Stepwise approach to technology introduction



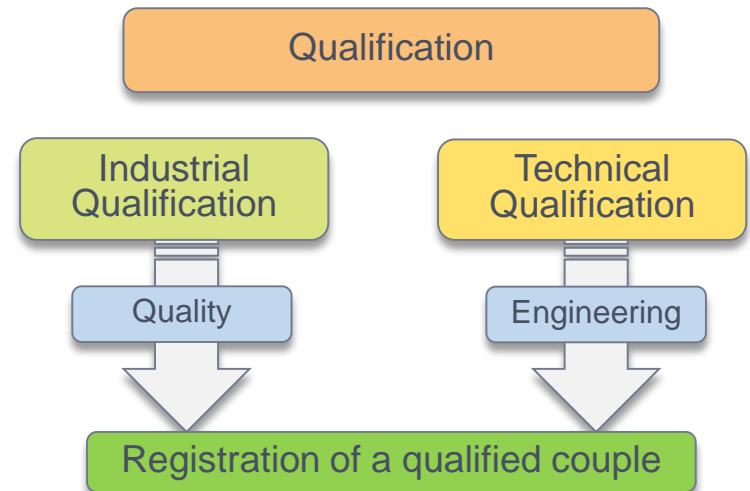
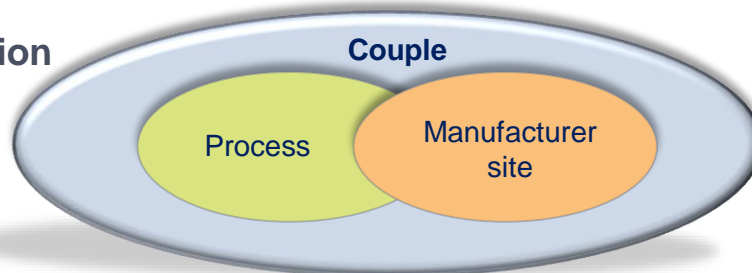
# What is a qualification?

- Qualification process demonstrates that a part / material / process:
  - complies with the requirements of the relevant referential and production process,
  - is performed in a robust and reproducible way.
- Basic requirement of EN 9100, Airbus Quality Assurance General Requirements.
- Two qualification approaches: Single Part Qualification or Process Qualification
- The result of Qualification is always a **“Couple”**.

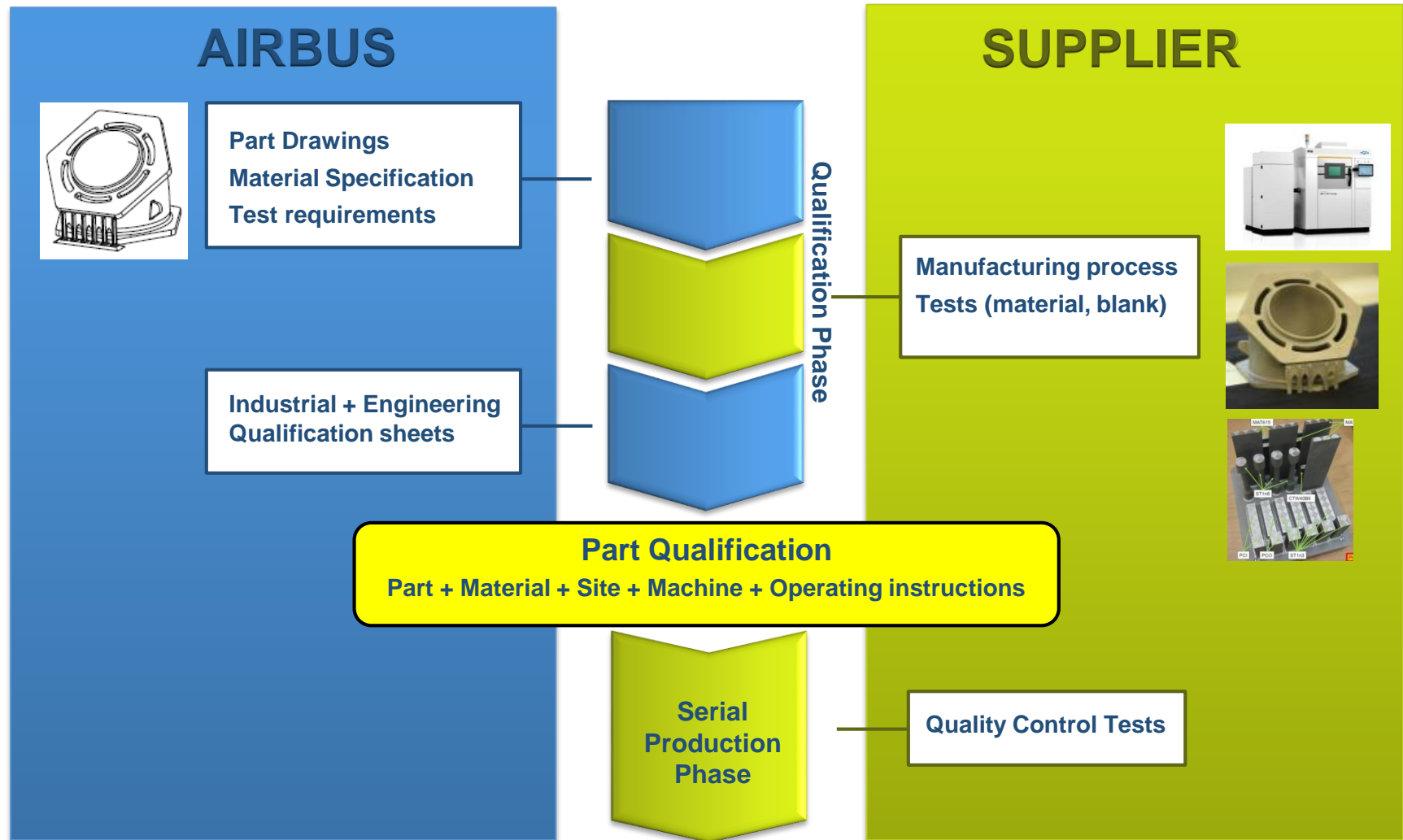
## Single Part Qualification



## Process Qualification

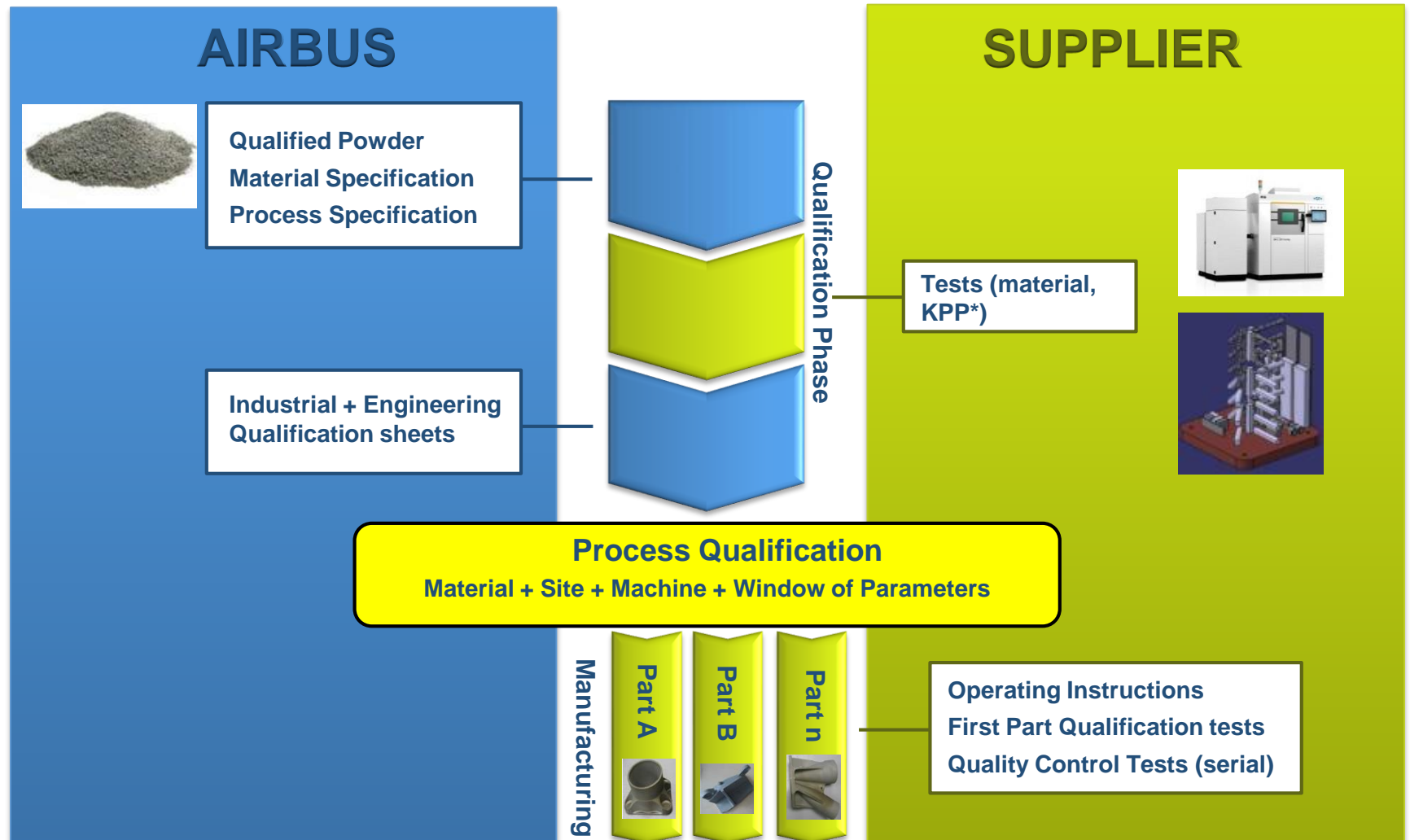


# Single Part Qualification





# Process Qualification



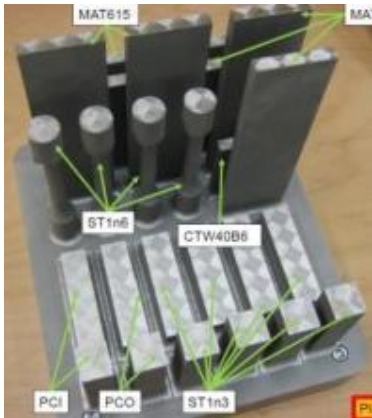
\*KPP = Key Process Parameters

# Tests to be performed in qualification and production phases

- Types of tests performed: static, fatigue, crack growth, toughness, roughness, micro / macro on cut-up, chemical, Non- Destructive Inspections (NDI).
- Amount of tests & inspections depends on Part criticality. Will be reduced while maturity increases.

## Generic Material qualification tests

*>150 specimens for new material*



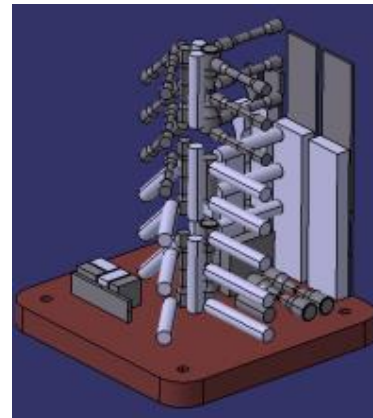
## Single Part qualification tests

*<30 specimens*



## Process qualification tests

*>300 specimens of 10 batches tested*



## Quality Control tests

*Several specimens per batch*



# Regulations

- Airbus position is that current applicable CS25 requirements remain applicable for AM
- Applicable regulations from draft EASA CM-S-008:

## Design & Construction

CS25.603 – Materials

CS25.605 – Fabrication Methods

CS25.613 – Material Strength Properties  
& Material Design Values

+ Domain specific



- Airbus procedural documentation developed and applied to ensure qualification of material, process and machines.
- Domain specific requirements and MoC will be defined, example structures:
  - Conventional structural strength characteristics, typical failure modes
  - Current structural analysis methods remain applicable.
  - Means of Compliance is analysis supported by test

# Regulations



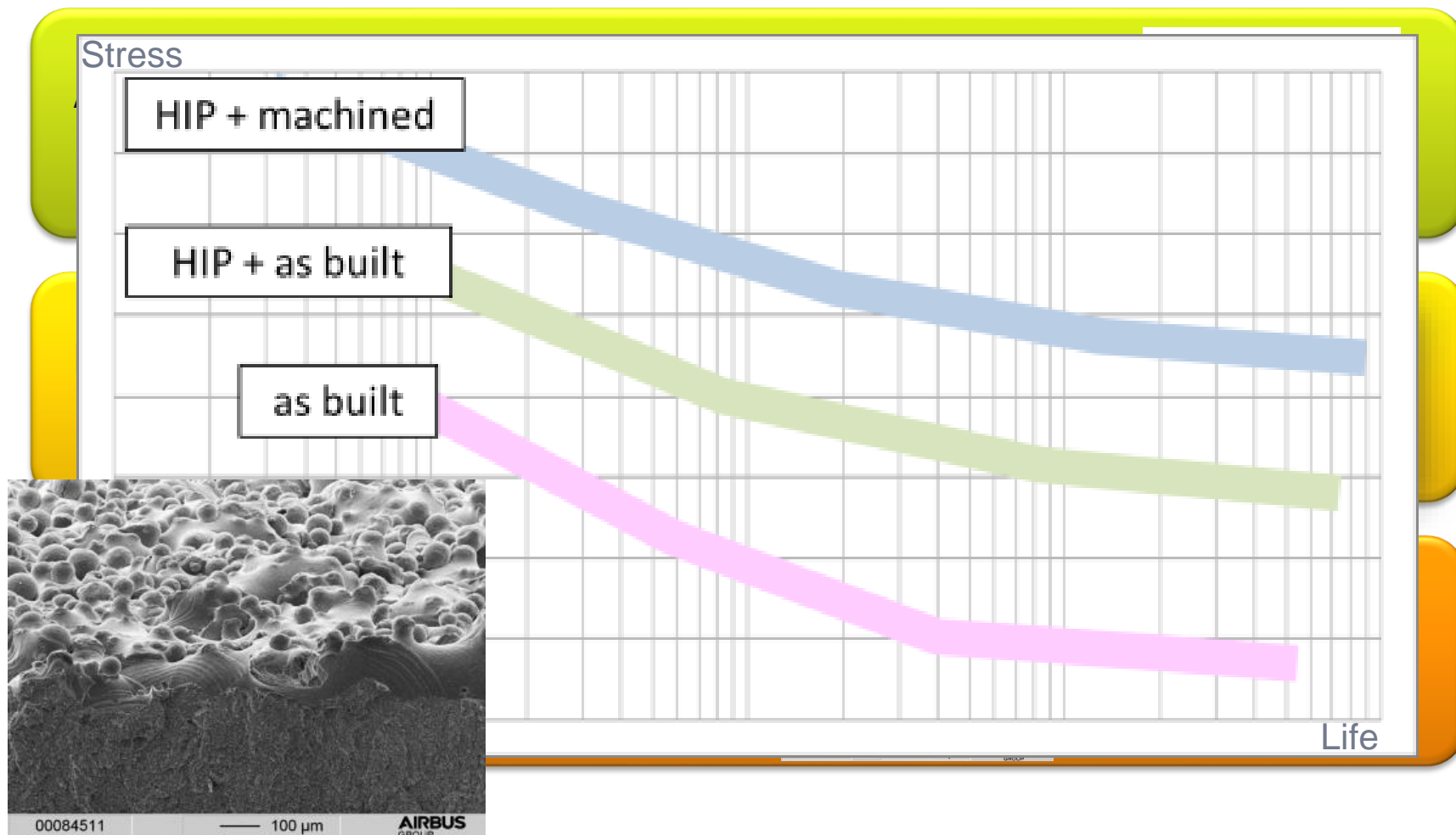
## Design & Construction

CS25.619 – Special Factors

-> Not applicable

- Why Airbus concluded Special Factors for structural strength not applicable?
  - Qualification of material, process and machines to highest standards
  - Design Values determined according to 25.613
  - Variability in Design Values in the range observed for wrought materials
  - Extensive quality process applied
  - Corrosion, environmental, surface protection, and aggressive fluid testing to ensure no deterioration in service.

# Points of specific attention



# Conclusion

- Airbus on the path to introduce Additive Manufacturing technology
- Stepwise approach followed
- Same approach as applied to introduce previous technologies
- Current regulations are applicable to Additive Manufacturing technology
- Lessons Learned - specific attention:
  - Effort needed for qualification
  - Rigorous processes and procedures
  - Fatigue and Damage Tolerance





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