



# **Airbus Views on Qualification of Non-loaded or Non-critical Parts**

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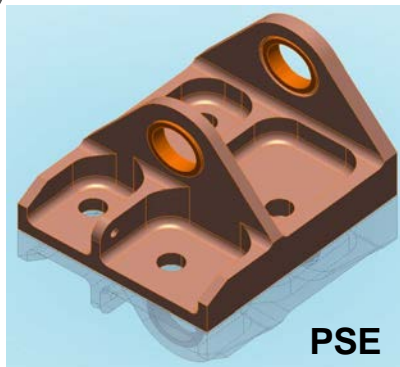
**AIRBUS**

# Objective

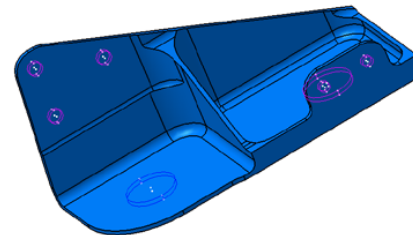
In case of similar parts, can we create a family for qualification?

Can requirements be reduced when maturity and process stability increases?

Must all parts have same requirements independent of importance, loading, complexity?



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**Tailoring of requirements to AM applications is crucial**

# Content

- **AM Metallic Alloys introduction in AIRBUS**
- **Key features of the E2E cycle**
- **Tailoring of requirements**
- **Examples**
- **Conclusions**



# AM metallic alloys introduction in AIRBUS

# Stepwise introduction

**Powder Bed Fusion and Directed Energy Deposition technologies**

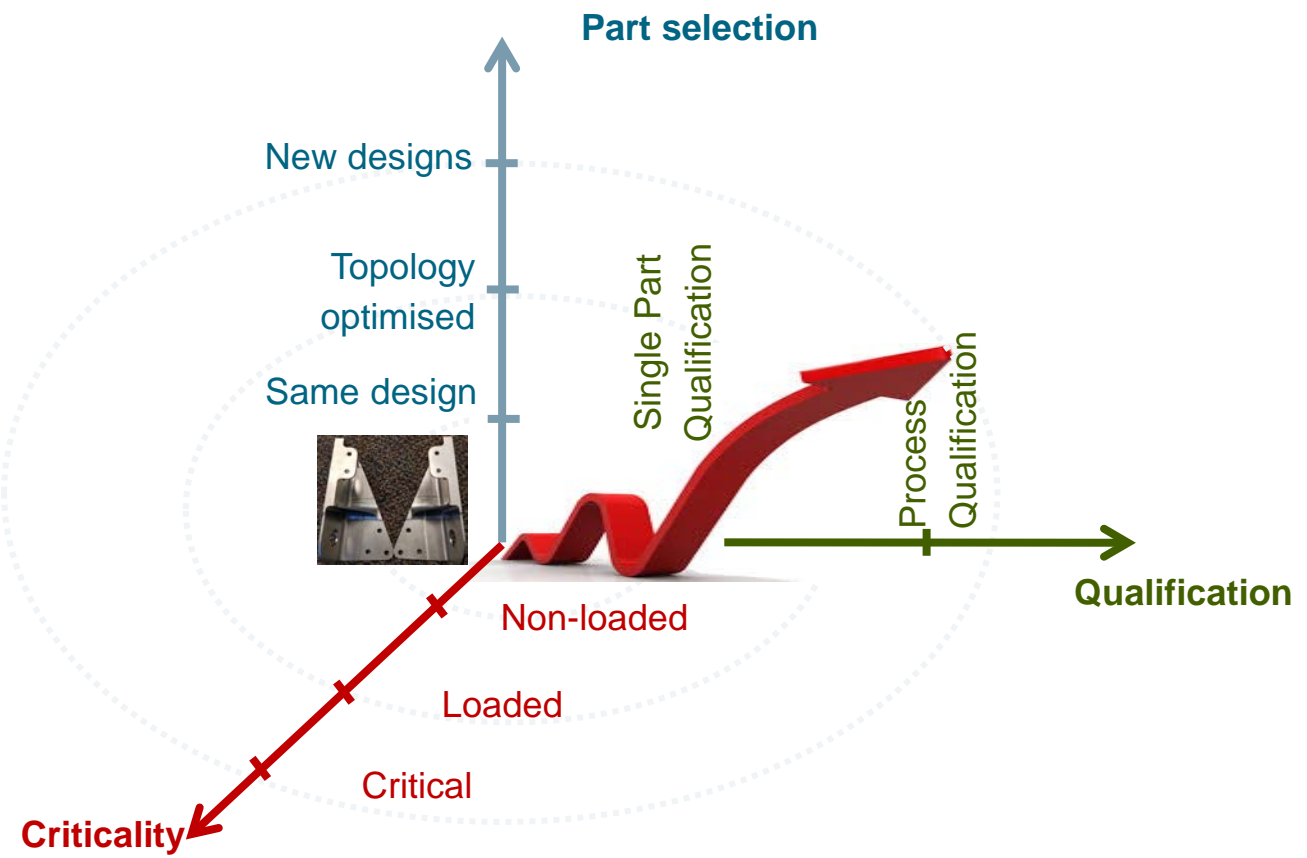
**Competences developed in AIRBUS with internal network of machines**

**Specifications developed for material and manufacturing process.**



**Step by step approach to ensure maturity**

# Stepwise introduction







## Key features of the E2E cycle

# Regulatory context

CS25 and FAR25 require approved material and process specifications

Relevance of parts for safety is indicated

## **CS 25.603      Materials**      (For Composite Materials see AMC 20-29)

I The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must –

(a) Be established on the basis of experience or tests;

(b) Conform to approved specifications, that ensure their having the strength and other properties assumed in the design data (See AMC 25.603(b); and

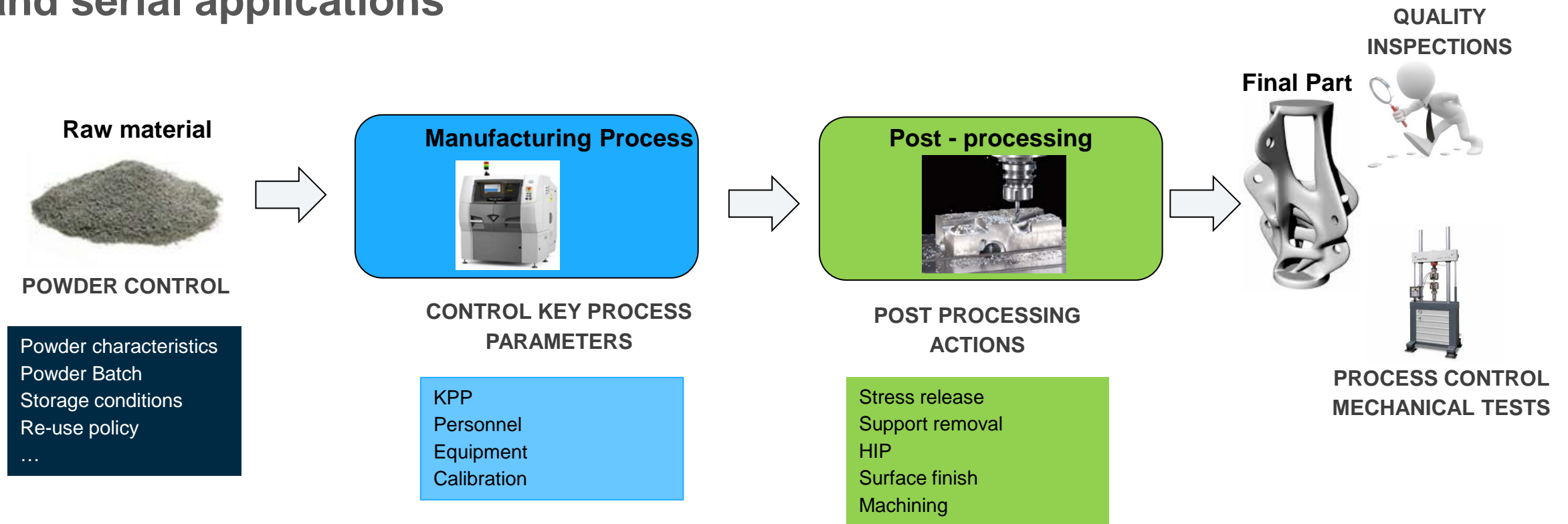
## **CS 25.605      Fabrication methods**

(a) The methods of fabrication used must produce a consistently sound structure. If a fabrication process (such as gluing, spot welding, or heat treating) requires close control to reach this objective, the process must be performed under an approved process specification.



# Current features

## High level of requirements applied on initial qualifications and serial applications



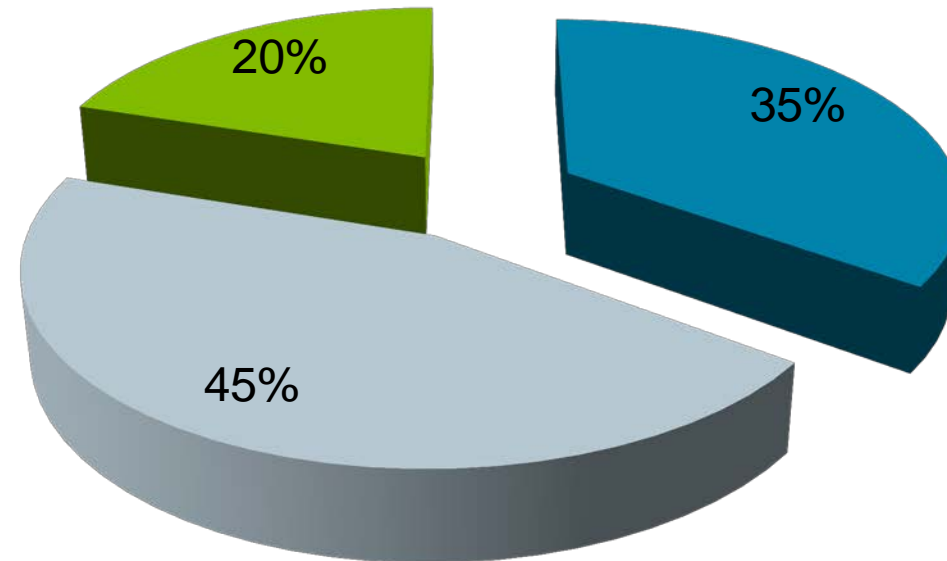
# Typical cost break down

Structural part

Powder bed techno

Indicative only

- 3D printing incl material
- Post processing
- Quality inspections



**2/3 of manufacturing costs are post printing**



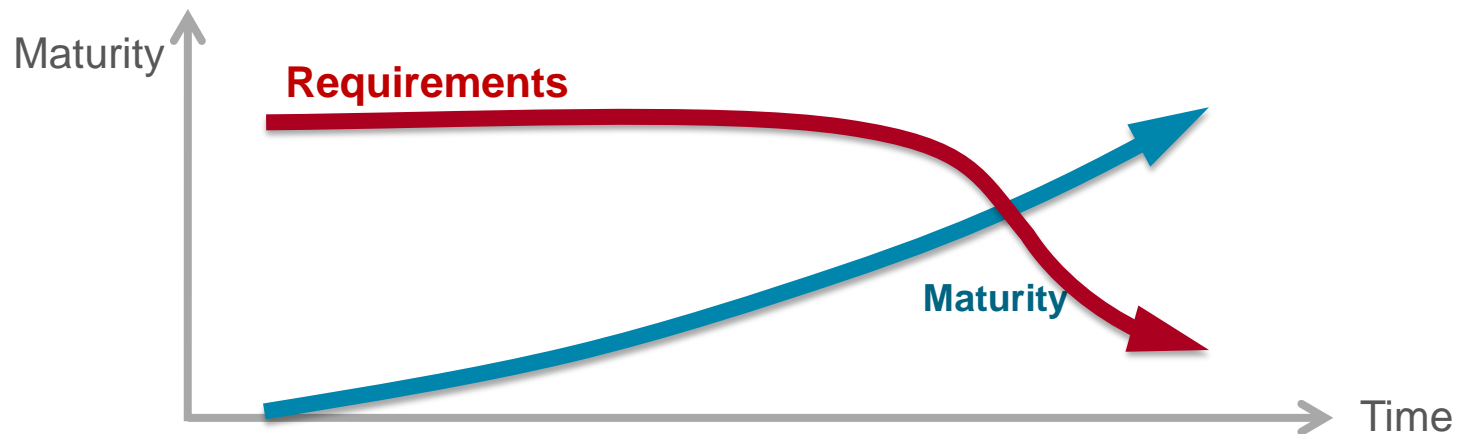
# Tailoring of requirements

# Maturity

High level of requirements for qualification, process monitoring, quality

Essential as the AM technology matures

Use lessons learnt, also from existing technologies (casting, composite)

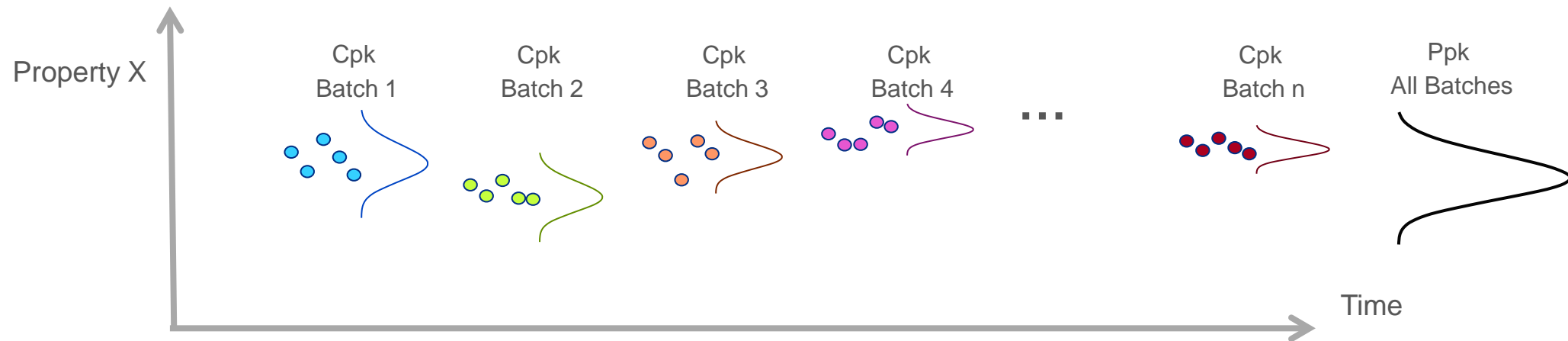


**Pre-requisite for tailoring: Understand effect of defect & KPP mastered and controlled**

# Process Control Specimen

Monitor Process variability

Process Capability (Cpk or variability index per batch) and Process Performance (Ppk or variability index over all batches).



Reduce number of PCS when process shows stability

# Part categories

4 different part categories can be distinguished:

- Fatigue critical parts
- Fatigue sized parts
- Static sized parts
- Non-loaded/ remaining parts



Requirements should be tailored to the category of part.  
Zoning of areas in parts could achieve even further refinement.

**Tailoring vs part category: focus on qualification, post processing and quality inspections/ testing**



## **Families for qualification**

**Successful qualification can be used to qualify a number of similar parts**

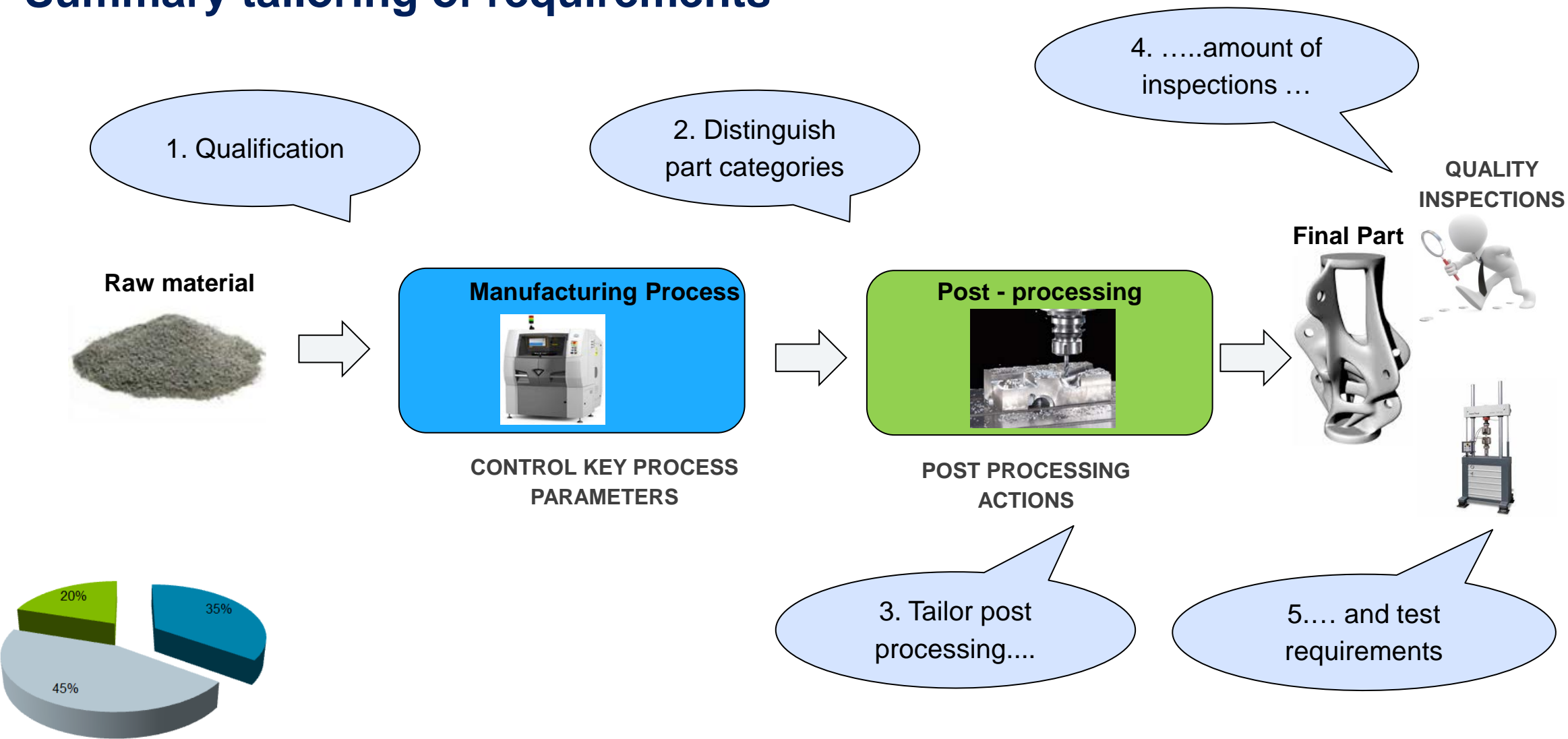
**Separate qualification of each AM part is not necessary.**

**To be considered as a ‘family’, the parts shall satisfy the following criteria:**

- **Same material and post processing conditions**
- **Same classification of part and part function**
- **Same manufacturing and inspection programme**
- **Similar geometry and section thickness**

**Qualification of a number of similar parts = qualification by ‘families’**




# Summary tailoring of requirements





# Examples

















# Example: possible tailoring of requirements for post processing treatment

Type of Parts	HIP	Support removal	Surface finish	Machining
Non-loaded/ remaining parts			As needed (*1)	As needed (*1)
Static sized	 (*2)		As needed (*1)	 Contact surfaces
Fatigue sized				 + fatigue critical areas as needed
Fatigue critical parts				 + fatigue critical areas as needed

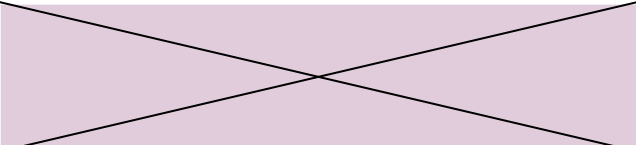
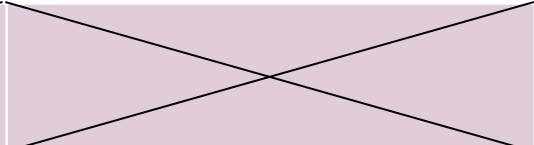
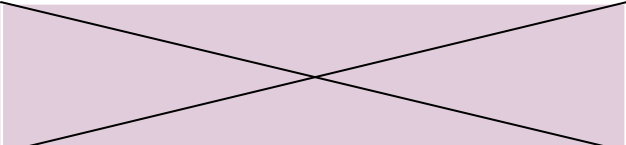









(\*1) – as needed (for paint/primer, cosmetic, corrosion protection, secure crack inspection, tight tolerance for assembly...)

(\*2) – When needed, HIP could be applied when low RFs. Qualif program should cover yes/no HIP.

# Example: possible tailoring of requirements for quality inspections

Type of Parts	X-ray or CT	Penetrant	Visual	Surface Roughness
Non-loaded/ remaining parts			 100%	
Static sized	 Sampling	 Sampling	 100%	 Sampling
Fatigue sized	 Structural significant internal areas + high likelihood	 100%	 100%	
Fatigue critical parts	 Structural significant internal areas + high likelihood	 100%	 100%	

## Example: possible tailoring of requirements for quality testing

Type of Parts	PCS mechanical testing		PCS surface Roughness		PCS metallurgy	
Non-loaded/ remaining parts						
Static sized		Sampling, reduce further after process stability (Cpk and Ppk)		Sampling		Sampling, reduce further after process stability (Cpk and Ppk)
Fatigue sized		Sampling, reduce further after process stability (Cpk and Ppk)				Sampling, reduce further after process stability (Cpk and Ppk)
Fatigue critical parts		100%, then sampling after process stability (Cpk and Ppk)				100%, then sampling after process stability (Cpk and Ppk)



# Conclusions

**Stepwise approach for serial introduction**

**Currently high level of requirements in Qualification and Serial production**

**Tailor requirements to part categories as technology matures:**

- **Qualification**
- **Post processing treatment**
- **Quality inspections**
- **Process control specimens**

**Pre-requisites: Effect of defect understood & KPP are mastered/controlled**

Thank you,  
Do you have some Questions?

