



Navigating the DOA to POA Transition with Additive Manufacturing

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It started with 1 part ...

Capabilities of full
production
35,000 – 40,000 per year

25%
**WEIGHT
REDUCTION**

20 → 1
PARTS

5x MORE
DURABLE



Current Status

US certified engines with Additive parts certified and in service or in the certification loop

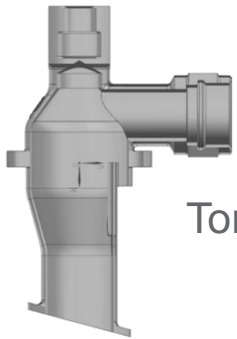
T25 Sensor Housing
GE90-94B



Fuel Nozzle
LEAP



European certified engines with Additive parts in the certification loop with the assistance of US technology



Torch Igniter
6 => 1



Inlet Case
27 => 1

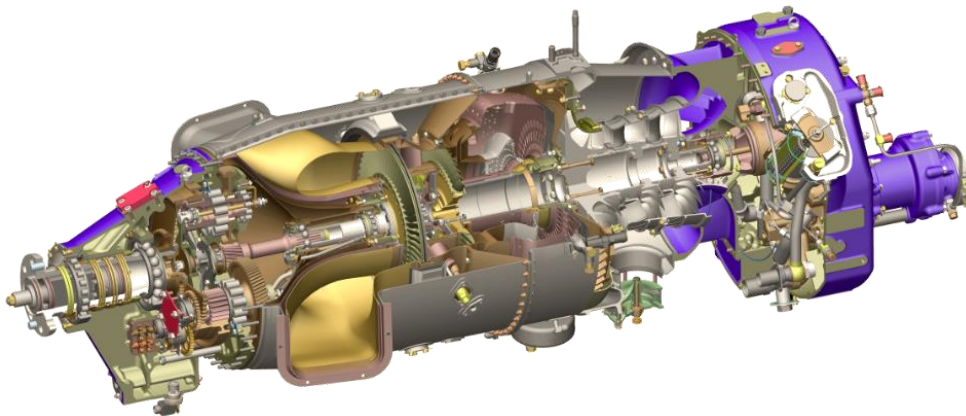


Diffuser
48 => 1



H-Series story

- GE Aviation Czech legacy turboprop
- Both DOA & POA functions on GEAC
- Additive benefits:
 - Cost reduction
 - Weight reduction
 - Simplification: ~100 parts => 4 parts

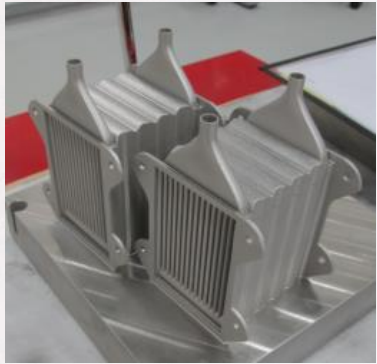


Then a system ... Advanced Turboprop
(ATP)

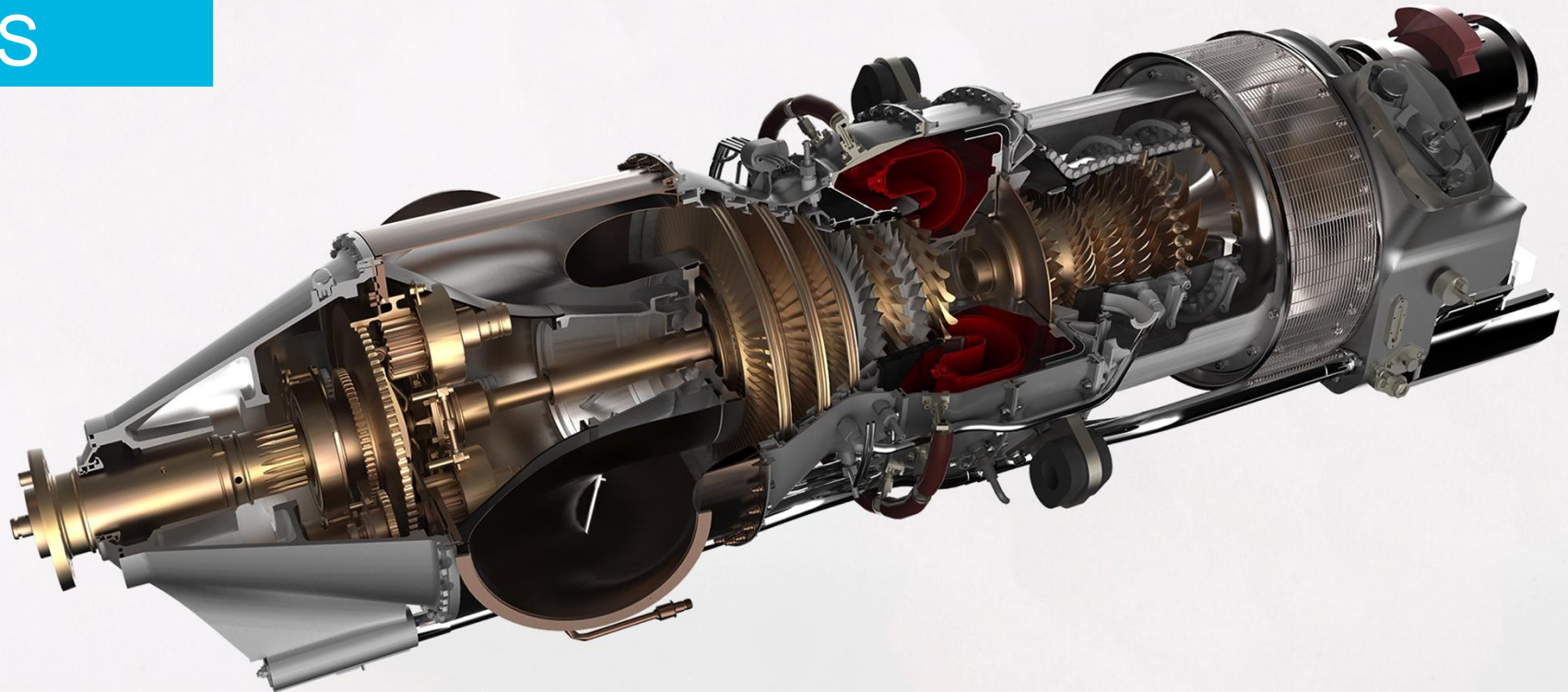
855 → 12

PARTS

5%
WEIGHT
REDUCTION

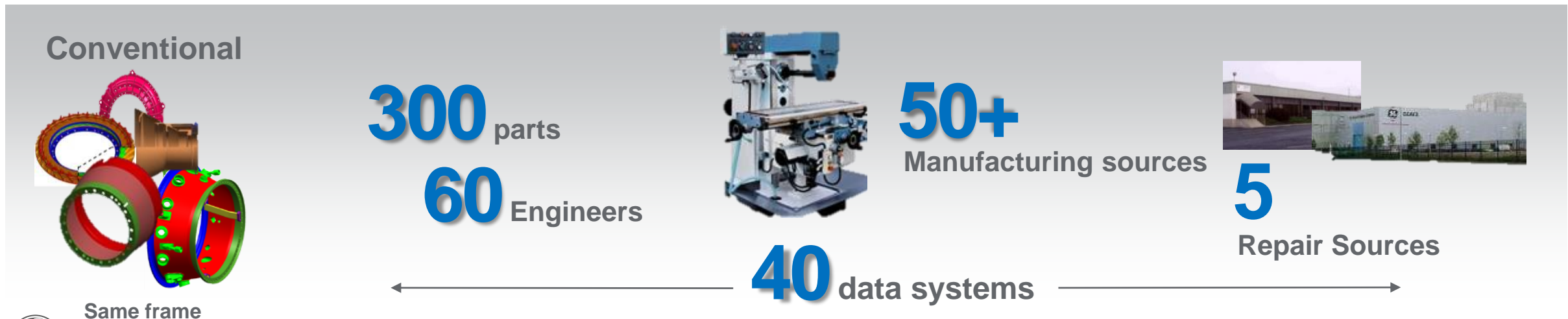


Heat Exchanger



Now at an enterprise level

Design → Manufacturing → Services



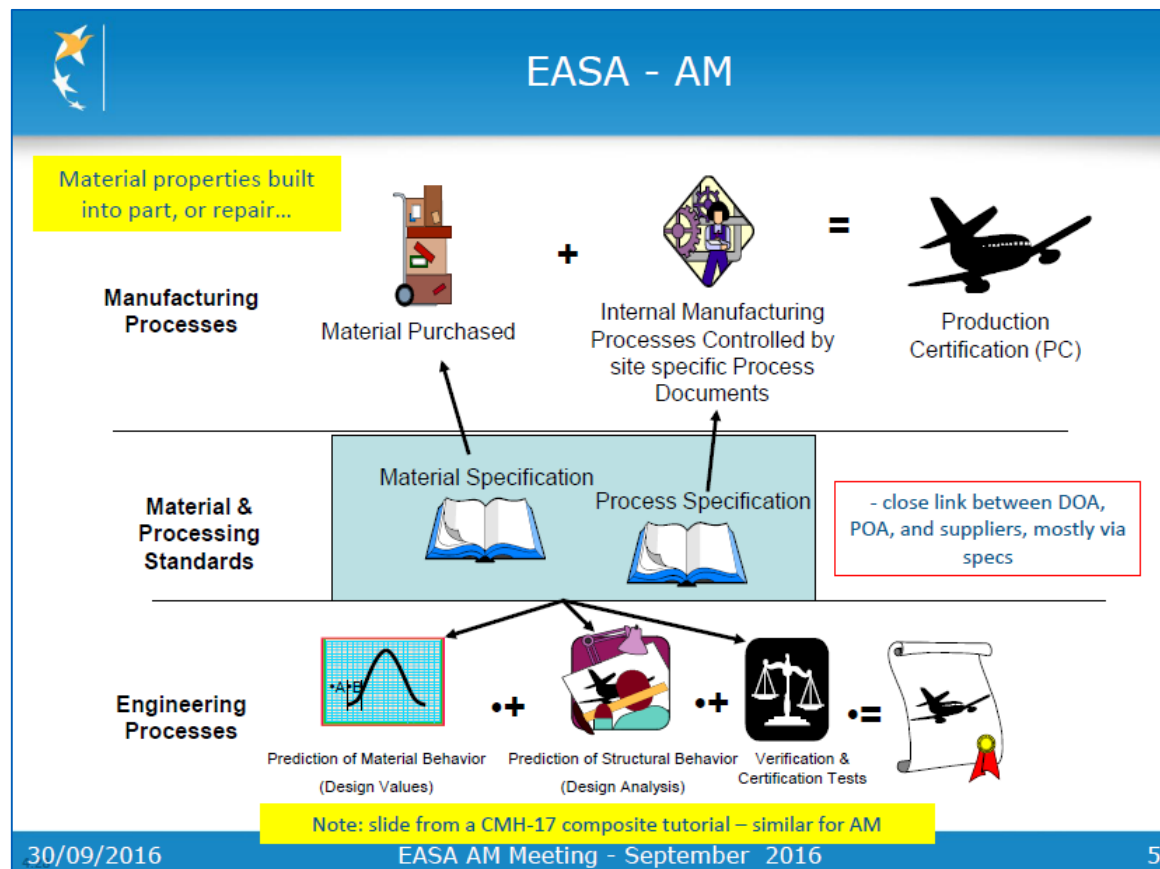
The ATP story . . .



What we desire from our regulators

- Understand the technology prior to determining whether new regulations are required
 - Current materials regulation CS-E 70 is “process agnostic”
 - We believe the currently regulations are sufficient
 - However new guidance material is both appropriate and required
 - Work with Industry
- Embrace Additive Manufacturing.... Be cautious but don't Fear it
 - Manufacturing Design Technology maturity is required for all modalities
 - set the bar high
 - Process understanding + robust design practices → successful introduction

The DOA to POA Transition

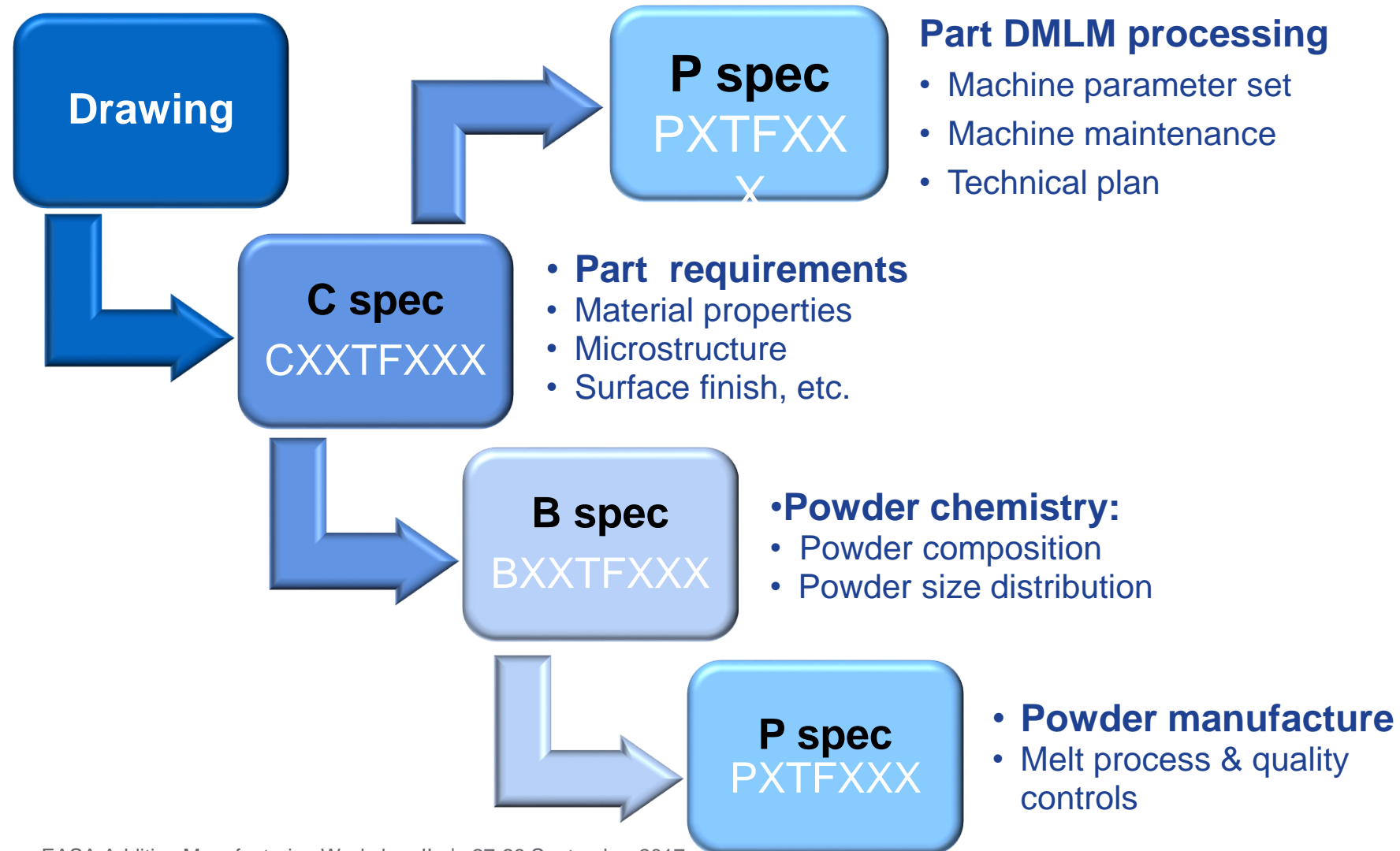


Simon Waite presentation (2016)

Key Deliverables

- Detailed Design Requirements
- Robust Specifications
- Robust Manufacturing Process
- Material Property Confirmation
- Verified Process Control

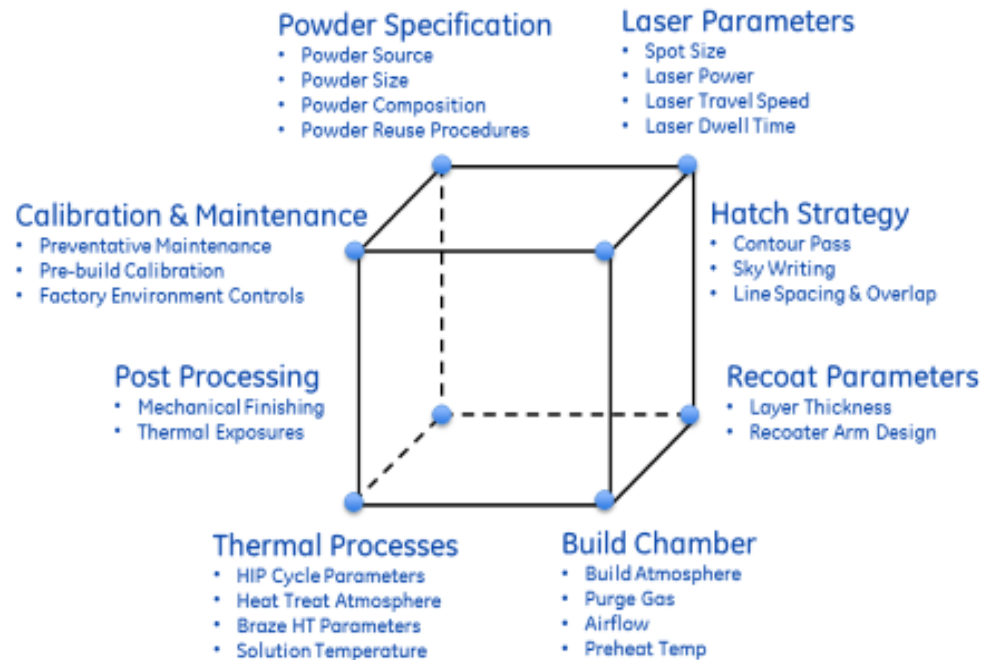
Robust Specifications



“Frozen” Manufacturing Process

Design

Additive Manufacturing development process
100+ Laser & Machine Parameters



Manufacturing

Each Machine ... Qualified separately and then
“frozen” process control

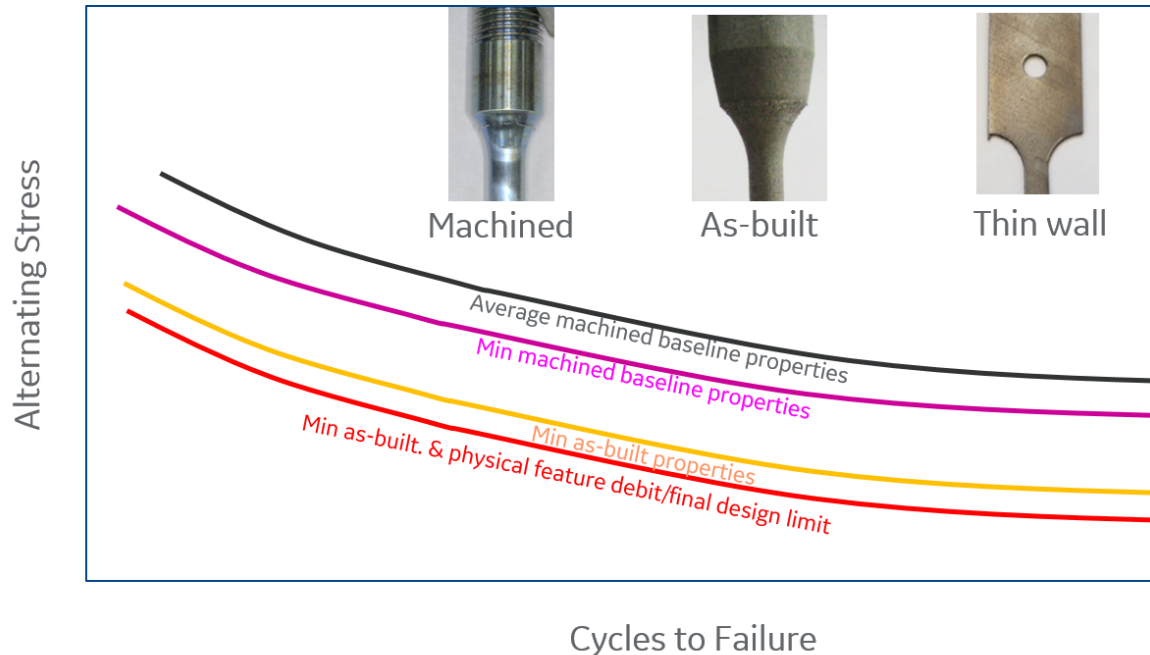
Material Qualification ... must buy-into material
allowable curves, must meet material specifications

Part Qualification ... process must be in
control, dimensional, functional



Material Property Confirmation

Design



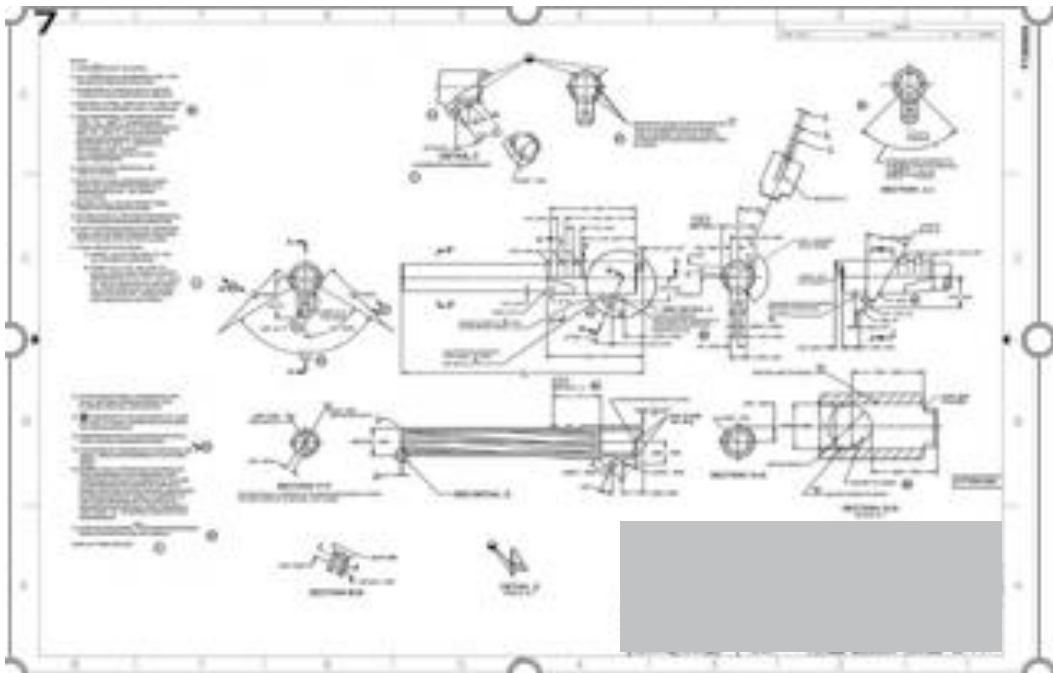
Manufacturing

Every build includes

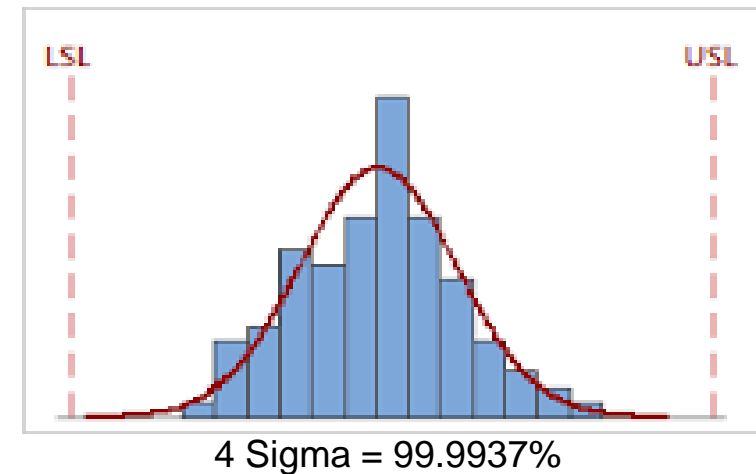
- Full part height representative specimens
 - tensile test – must meet material specification strength and elongation requirements
 - microstructure - must meet material specification requirement for microstructure, anomalies, and interstitials
 - fatigue tests – performed periodically at drawing specified temperatures
 - additional bars stored for potential tensile, fatigue microstructure and chemistry evaluations

Verified Process Control

Design



Manufacturing



- Dimensional conformity
- Process control over multiple builds
- Machine variation
- Position variation
- Quality plan (cut-up and NDT)

GE's approach to additive manufacturing . . ▪ is the same as any other manufacturing process

- Rigorous TRL/MRL development program
- Well defined specifications and process validation
- Quality ensured by process control

