EASA - FAA AM Workshop

Nov 5, 2019

GE Follows Industry* Process

Process steps are often performed in parallel. Sequence may not be as shown., however the completion of each element is required

* Industry refers to the AIA Working Group for FAA qualification of AM components. Graphic taken from WG white paper

Development Process

- Material & parameter development
- Specification development
- Post-process development
- Part development
- Machine operational qualification

Supply chain qualification

- Process control documents
- Process performance qualification

Material property development

- Material allowables
- Design values

Part design qualification

- Building block approach

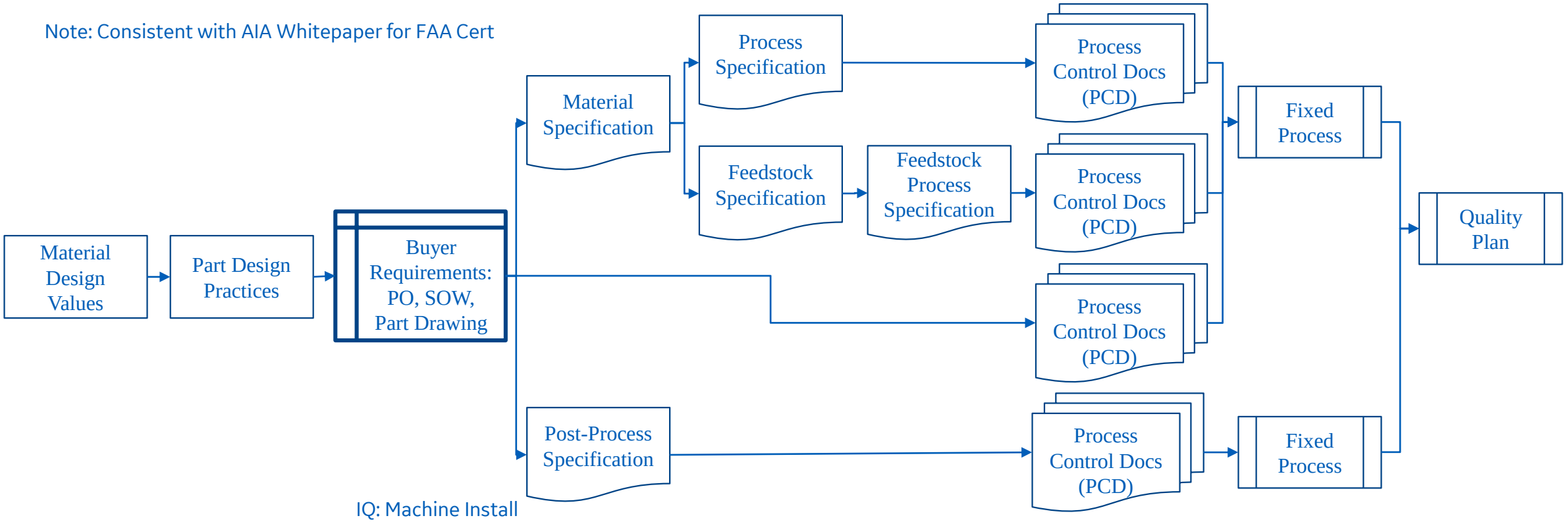
Quality Controls

- Quality plan
- Inspection methods

GE Additive Part Qualification

Why: Requirements Development | What: Requirements Definition | How: Process | Outcome

Note: Consistent with AIA Whitepaper for FAA Cert



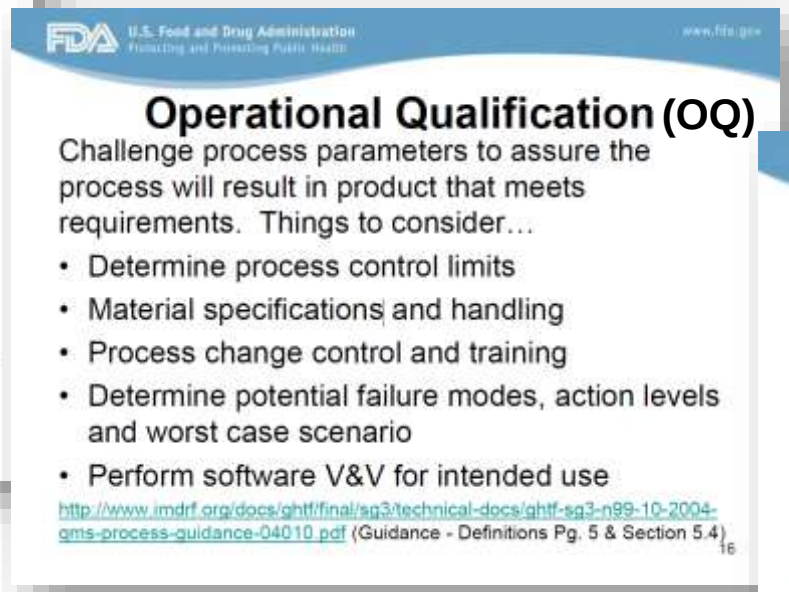
IQ: Machine Install

Engineering Qual (Materials & Design) | OQ: Machine & Material Qualification | PQ: Part/Process Qual. | Verification

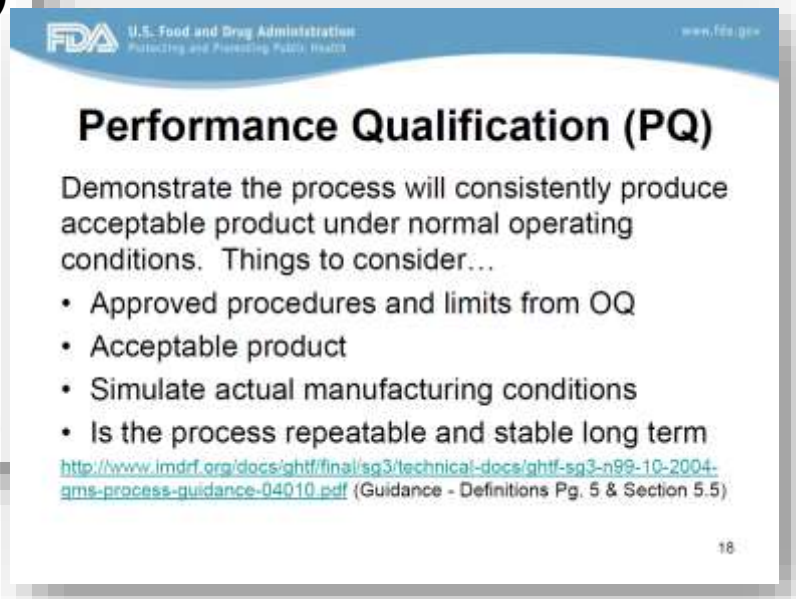
Note: IQ/OQ/PQ next page

IQ/OQ/PQ: Leveraging Qualification Language from the FDA

Machine OEM Qual to Customer Req't



Machine Qual to Material Spec

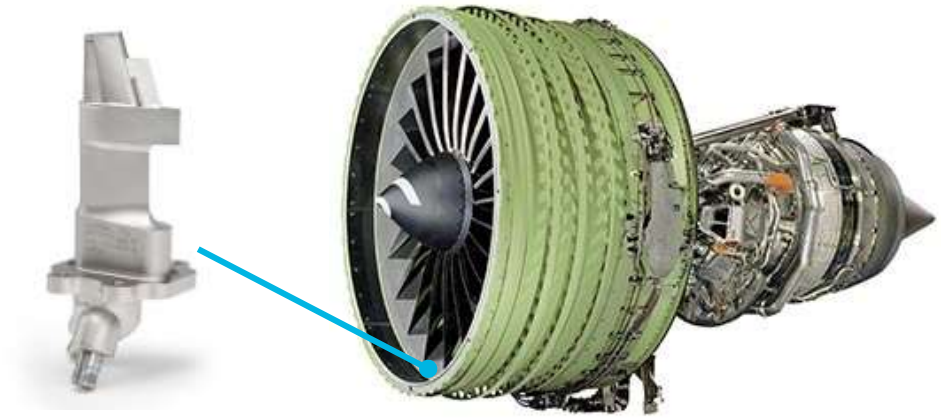


Process Qual to Product Req'ts

Commercial aviation qualification categories are consistent with FDA definitions.
Qualification elements and requirements within each category are very different for FAA/EASA vs. FDA

GE Aviation Use of AM in Commercial Products

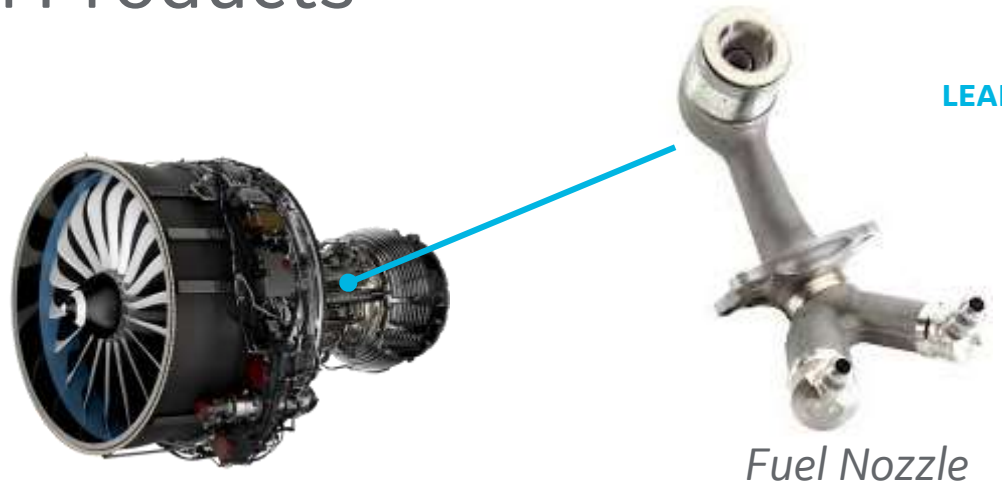
GE90-94B



T25 Sensor

2014: 1 AM Part

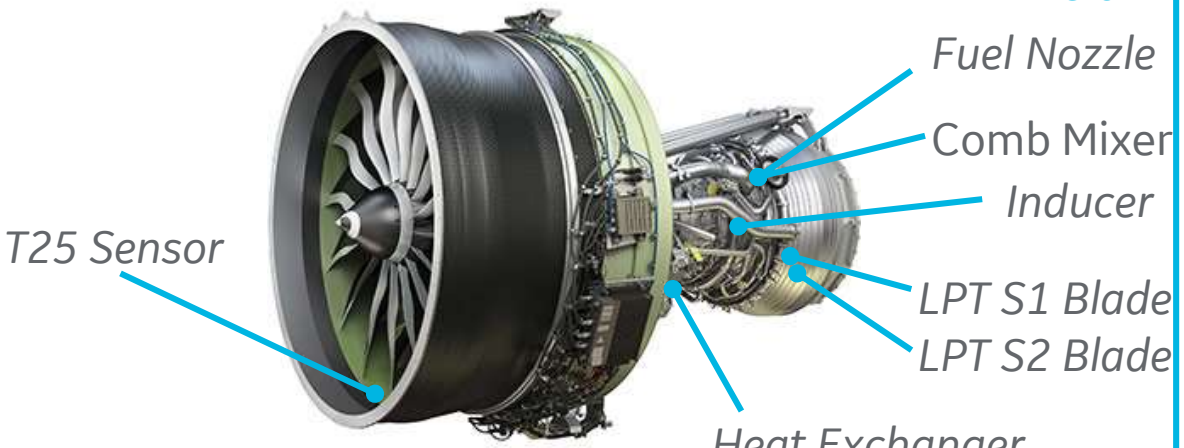
LEAP



Fuel Nozzle
19 per engine

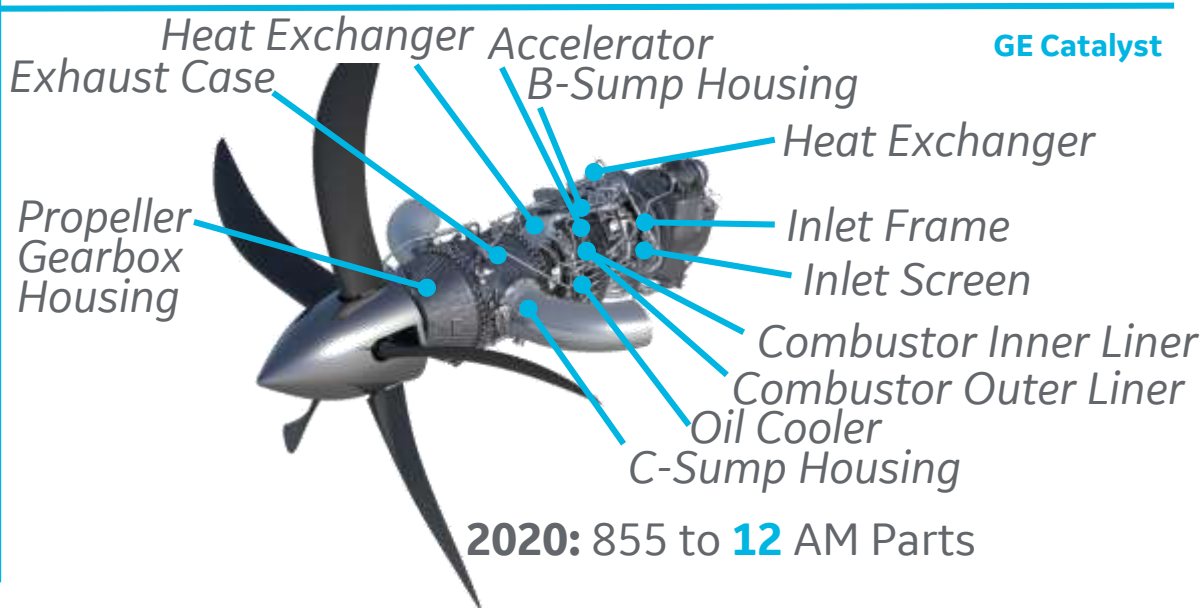
2014: 20 to **1** AM Part

GE9x



2020: 7 AM Parts

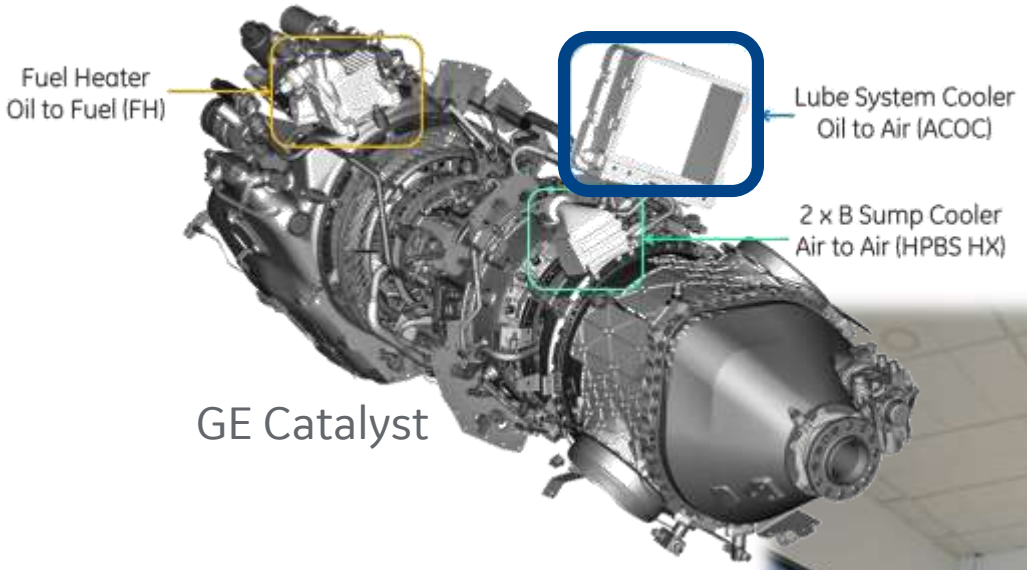
GE Catalyst



2020: 855 to **12** AM Parts

Additive Heat Exchanger Design Example

Additively designed ACOC (Air Cooled Oil Cooler.
The ~25 inch component can be produced in a single machine.

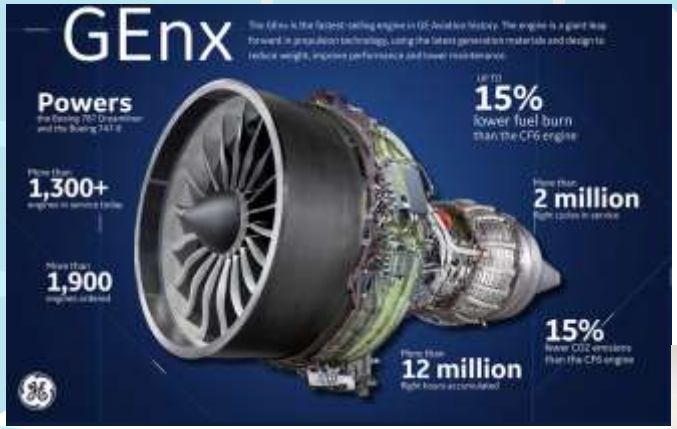


GE Catalyst

Part Application and Criticality vs. Manufacturing Method

Regulations *(independent of method)*

Manufacturing Process	14 CFR 21	14 CFR 23	14 CFR 25	14 CFR 33	14 CFR 35
Fabrication					
Forging					
Casting					
Additive					



Qual & Cert Considerations
Material durability
Vibration & fatigue effects
Operating & max loads
Effects on system
Weight & CG

PDOS Bracket

example