#### Eaton Aerospace Additive Manufacturing 7<sup>th</sup> Joint EASA-FAA Additive Manufacturing Workshop

September 17th, 2024



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## Introduction

- Professional:
  - FED AM Engineering Specialist, Eaton (3.5 years)
    - Develop and Deploy Additive Manufacturing across Fluid and Electrical Distribution (FED) Division
    - Support AM Applications for 13 Sites and 21 Product Lines
  - Senior Design Engineer Additive Manufacturing, Eaton (2 years)
    - Lead AM IRAD programs for Fuel, Ducting, and Joints products
  - Design Engineer, Eaton (2 years)
    - Design and Sustaining for Fuel and Pneumatic Joint Products
- Education:
  - BSE Mechanical Engineering, University of Iowa



Frank May Eaton Aerospace Additive Manufacturing Group





#### Eaton's Additive Manufacturing

- Introduction
- Eaton Aerospace
- Eaton's AM Roadmap
- Development to Qualification of AM
   Products



#### Eaton's Aerospace Group

- \$3.4B\* in 2023 sales
- 41 global facilities
- Approximately 12,000 employees
- 4 Aerospace Divisions:
  - Fluid & Electrical Distribution (FED)
  - Fuel & Motion Control Systems (FMC)
  - Interconnect Technologies Division (ITD)
  - Mission Systems Division (MSD)

\*Aerospace segment as reported

Aerospace Group Headquarters
 APAC Regional Headquarters
 Divisional Headquarters
 Manufacturing facilities

Sales & support offices
 Engineering Centers
 Eaton SAMC joint venture



#### Eaton's World-class Aerospace portfolio



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# Eaton leverages additive manufacturing to create superior product solutions for our customers





#### Eaton's Additive Manufacturing Deployment since 2017



#### Eaton AM Pedigree – Awarded Programs



#### Eaton Aero – awarded 34 AM component

#### Qualified Metallurgical Process (QMP) Roadmap



Focused on Aluminum (AlSi10Mg), Titanium (Ti6Al4V), and Stainless Steel (316L/17-4PH) for Metal Additive





#### EASA Certified Eaton AM Product – A330 Jet Pump

#### Jet Pump

- > Material & Process: AISi10Mg, L-PBF
- **ENG Location**: Titchfield, UK
- Application: Fuel scavenge Jet Pump. Product utilizes orifice to accelerate and transport fuel.
- AM Benefit: Application enabled Eaton and Airbus to validate AM benefits of Weight, part consolidation and lead time



Powering Business Worldwide

#### 2 Jet Pumps Per SS

30% Weight reduction / part
11+ → 1 part reduction / Jet Pump
40% Lead time reduction
EASA Certification











AIRBUS

















# AM Qualification today is slow and expensive. AM Guidance from FAA/EASA may reduce future qualification effort

#### Today

## Limited guidance from industry for AM Qualification

- Customers limited experience on certification and acceptance of additive drives conservative approach
- Must demonstrate capability to customers

#### AM requires extensive qualification effort

- Full material characterization required
- All component testing in full assembly
- No qualification by similarity
- No qualification by simulation
- Extensive testing... time & cost

# To streamline deployment and acceptance of AM:

- Internal Spec align with industry guidance
  - NASA, AIR, AWS, etc.
- Standardize Dev/Qual plans
- Internal Audits against industry specs
  - NADCAP, FAA, SAE, AMCOM
- Invite customers to Eaton's AM facility for in-depth review

#### Tomorrow

## Guidance Area's needed from FAA/EASA to streamline acceptance

- Preferred Industry Standards for AM
- Eaton's customers AM requirements based on FAA/EASA's recommendations
- Part criticality with defined minimums
- Qualification of next generation technology

#### AM qualification by similarity & simulation

- Similar requal to traditional mfg methods
- Reduced turn-time & cost to qual
  - Leverage qualification data to scale back qualification testing



## Summary

- Eaton AM progress has led to:
  - **18** AM products in production and **34** total awarded programs
  - Multiple M&P combination qualified
  - Aerospace dedicated Additive Manufacturing Center
  - Internally developed qualification framework based off industry guidance
- Support needed from FAA/EASA on guidance to OEMs on AM requirements or specifications

Ultimately, it is Eaton's responsibility to ensure our products meet our customer's requirements



