EASA/FAA Additive Manufacturing Workshop 2019

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Closing Presentation of Working Group 1

Co-chairs

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Problem Statement

Standardization of the qualification of AM machine and material would benefit both the machine OEM and part producers (type certificate and service bureau)…

Working Group 1 Topics

Working with the WG1 core team, we down-selected 2 topics to be discussed in todays workshop .

Topic 1 Key Process Variables

Topic 2 Qualification of Identical Machines

Topic 1 Key Process Variables

Addressing comments from 2018 EASA Workshop

- Guidance from TCH's, AM part suppliers on how process variables are classified as key process variables.
- Guidance from Machine OEM's on process variables based on previous experience that could be classified as significant.

Workshop provided the opportunity to address the comment – to engage TCH and Machine OEM's on the important topic of KPV. Discussions were relevant to other WG participants.

Topic 1 Key Process Variables

Addressed the following questions:

What makes a Process Variable a Key Process Variable (KPV)?

- A process variable that has a significant effect on a process “Y”
  - Such as chemical, physical, metallurgical, mechanical, or dimensional requirements
  - Application specific requirements may include anomaly limits, surface finish, fatigue, creep, etc.
- Key process variables vary by AM process and may include:
  - Machine process variable values
  - Other process characteristics that may vary during the build
  - Process characteristics that should not change between builds:

Topic 1 Key Process Variables, 'cont'

What is the significance of defining a Process Variable as a KPV?

- Need to understand the impact of changes to a KPV to the Process Y's
  - This includes the interactions between the KPVs.
- Process Requalification if changed (full or partial depending on change)

How are Key Process Variables determined?

- A Design of Experiment (DOE) is run to determine which process variables can affect the Process Y's described earlier.

Topic 1 Key Process Variables, 'cont'

Discussion on Adaptive Control

- Example: Meltpool control for DED process – Adaptive control of KPVs that affect melt pool size (i.e., power and feed). Camera monitoring size of melt pool leads to active control of the feedstock feed speed to maintain the melt pool size.
- Concern expressed that there is experience with AM software containing "bugs", especially concern with adaptive algorithms implemented.
- Type Design Holder input in meeting is that adaptive control is not yet ready. Position was that we should continue to get more experience on current processes, while supporting future developments such as adaptively controlled processes.
- This is a process approach that will continue to be developed and a topic for future discussion.

Topic 2 Qualification of Identical Machines

Will address the following questions:

- Can we determine an equivalence resulting in a limited qualification exercise, a subset of the initial qualification exercise to meet a certain specification?

- How can we maintain good configuration management of the machine, BOM?

- Can we define a track record of variability of different machines produced to visualize the trends?

Discussion

- Machine to machine variability has been confirmed by several parties in the WG session
- Good configuration management, traceability, and characterisation of differences is key to understand any impact at product level
- Requalification represent a significant cost to the end user
- Lack of guidance how to address variability.
- Are we setting re-qualification standards to high?
- Need for standardisation of requalification of machines.
- Put sanity into discussion, requalification of machine is essential for critical parts, probably less for other parts.
- Industry stated: safety is not only accept to be considered, reliability and durability considerations are also important

Next Steps

- Can a requalification standard be defined within the AM community, a common set of requirements, also addressing the criticality subject?
- Can a machine acceptance testing be standardised to address part of the requalification effort?
- Can the promising NCAMP equivalency works in polymer be used? About 10% testing of full matrix to check if it pools.
- Can round robin testing be performed to quantify variability?
- Consider what is done for conventional technologies.

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