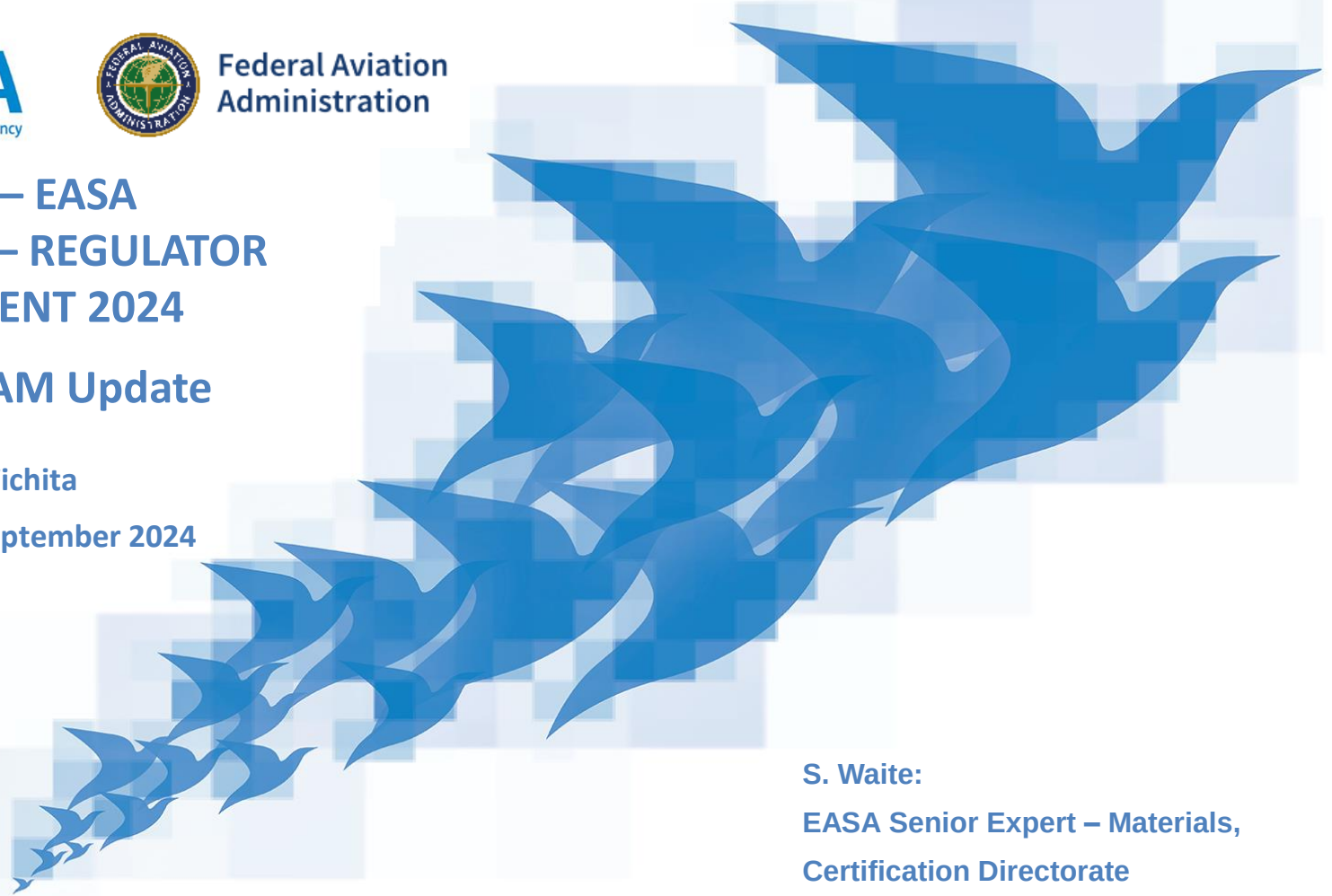


FAA – EASA
INDUSTRY – REGULATOR
AM EVENT 2024

EASA – AM Update

Wichita

17-19th September 2024

S. Waite:

EASA Senior Expert – Materials,

Certification Directorate

EASA - AM

EASA Update 2024:

1/ 2023 EASA FAA AM Event Reminder

2/ Advanced Materials and Processes - Developing Rulemaking and Guidance

- CS25 amdt.27 – AMC 25.603 & 605 revision (reminder)
- EASA AM CM-S-008 ‘Additive Manufacturing’ revision CRD to be discussed in WG1

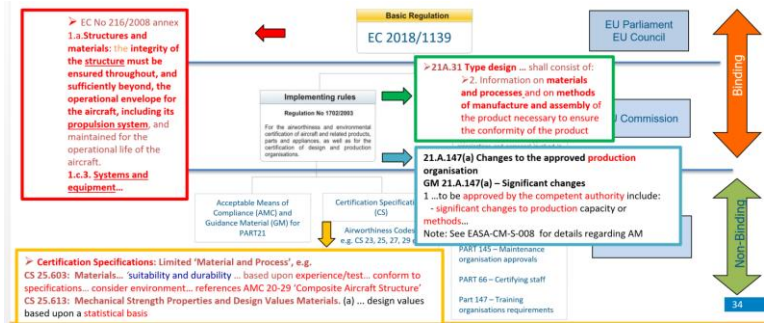
3/ European Aviation AM Industry Regulator Group (EAAMIRG)

- brief update since 2023
- EAAMIRG Action 2 ‘Standards and the Use of Standards’(see presentation by Richard Mellor - Rolls Royce)

EASA – AM REMINDER

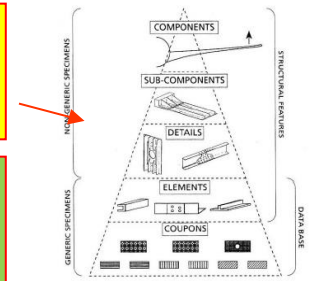
Reminder: Existing Regulatory Context/Framework (moving toward, **Performance Based Regulations** (PBR))

- Regulations relating to 'material, process, manufacturing methods' are built into the 'Binding Regulations'



Where are the 'engineering properties' developed in the pyramid?

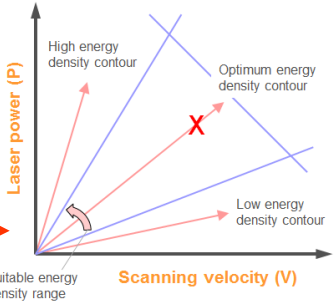
Note: 'Pyramid' definition under development for other 'advanced materials' technologies, e.g. composites, see CMH-17



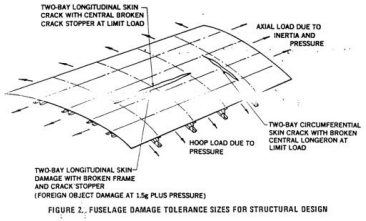
1 - Schematic diagram of building block tests for a fixed wing.

- 'Engineering Properties' are defined by 'material, process, manufacturing methods' & built directly into the (complex) part or repair

- sensitive processes and competing damage modes, some difficult to detect
- identify Key Process Variables & Parameters, including sensitivity of engineering properties to these…



- change not to reduce the existing 'acceptable' level of safety
  - complex reference point
  - use 'robust' design concepts
  - 'Step by Step' approach wrt criticality
  - test v analysis?
  - optimised design….more low margins?... needs more testing, not less? (divergent industry Modelling and Simulation discussion)



EASA - FAA

Reminder: established annual industry – regulator AM Event, hosted alternate years by EASA or FAA.

Industry-Regulator AM Event 2023

(EASA hosted, Face to face and virtual)

80 organisations represented

60% EU
25% US
15% Other

Working Group F2F Attendees:
- WG1 75
- WG2 40
- WG3 44

EASA - FAA

Industry-Regulator AM Event 2023(F2F)

Reminder/Summary:

Keynotes:

Event:

'Review on fracture-based fatigue assessment for net-shape metal surfaces manufactured by L-PBF and its application to component qualification'

Prof. Stefano Beretta, Politecnico di Milano, Italy

In Process Monitoring Theme:

'Status AM@MTU: A proposal for cost effective quality assurance'

Sebastian Rott, Julian von Lautz, Andreas Fischworring-Bunk , MTU

EASA

Joint EASA-FAA Additive Manufacturing Workshop 2023

EASA and FAA are co-organizing the 6th joint EASA-FAA Additive Manufacturing Workshop to be held at EASA in Koeln (Cologne), September 19-21st 2023.

As industry, government agencies, and academia transitions back to 'Face to Face' (F2F) meetings following the COVID restrictions, and also noting the increasing attendance at this Event in the virtual format during this period (about 450 at the 2022 Event), EASA and FAA wish to return to the F2F format to realize the benefits gained from such meetings in the past, within the bounds of available conference room capacity. Therefore, the 2023 Event will be formatted as a F2F workshop by 'invitation only', with priority given to those directly contributing to the Event agenda through including Working Group (WG) Breakout Sessions (see below) and presentations.

Background:

In response to industry interest and rapid expansion in the use of Additive Manufacturing (AM) methods in aviation products, the European Aviation Safety Agency (EASA) started offering workshops on C&C of AM in 2015, focused on qualification and certification (C&C) of AM parts in order to promote the technical dialog and knowledge sharing between the key stakeholder groups, including government agencies, industry, public standards organizations and academia. The FAA started offering workshops on C&C of AM as well in about the same timeframe. The first three FAA workshops were produced in partnership with the United States Air Force (USAF) and the Air Force Research Laboratory (AFRL). As a part of this process and in response to industry requests, EASA and FAA have been increasingly working together, resulting in collaboration and alternate hosting of an annual joint aviation AM event by EASA and FAA, with the past events having been hosted by EASA in Koeln in 2019 and virtually in 2021, and by FAA in Wichita in 2018 and virtually in 2020 and 2022. The presentations and outputs from these events are available in the public domain (see References section for the link to the 2021 and 2022 workshop's proceedings).

'Technical Talk' Themes 2023:

- **In-Process Monitoring (NDI and other parameters)** - support growing theme and WG3 discussion development
- **No and Low criticality (MROs etc) using AM** - support WG1 and CM-S-008 Revision

Note: the industry mostly agrees that today's machine monitoring technologies are not robust enough to be used in qualification of flight worthy components. However, the experts also generally agree that there is a need for this technology to mature so that it can be used as one of the tools supporting this task. See WG3.*

**e.g. ASTM Strategic Guide: Additive Manufacturing In-Situ Monitoring Technology Readiness (2023)*

EASA - FAA

Industry-Regulator AM Event 2023(F2F)

Outline:

Joint EASA-FAA Additive Manufacturing Workshop 2023

EASA and FAA are co-organizing the 6th joint EASA-FAA Additive Manufacturing Workshop to be held at EASA in Koeln (Cologne), September 19-21st 2023.

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Working Groups 2023 (break-out sessions/summaries):

Working Group 1 (continued from previous meetings): Qualification of AM Parts of No, or Low, Criticality (for use in Certified products)
Co-chairs: S. Waite (EASA), O. Kastanis (EASA), D. Hedges (Senior Advisor, Additive Manufacturing, TRUMPF)

Working Group 2 (continued from previous meetings): F&DT and NDI Considerations for Metal AM
Co-chairs: M. Gorelik (FAA), A. Fischerworring-Bunk (MTU)

Working Group 3 (new/evolved from previous meetings, also linked to WG2): Developing a Five-Year Plan to Allow EASA / FAA acceptance – Machine Monitoring
Co-chairs: F. Lartategui (ITP AERO), D. Godfrey (SLM Solutions)

Regulator Panel Session (Moderator Mark Shaw (WSU-NIAR), regulators FAA, EASA, TCCA, CAA UK, NASA)

EASA AM

Further to the 2023 Event…

- growing number of new and potential applications
- majority of applications of ‘no or low’ criticality

EASA effort attempting to prioritise developing industry needs, e.g. WG1 ‘no and low’ criticality activities with respect to **‘step by step’ approach to criticality**

- **CM rev. text development** driven by industry questions to EASA, not ‘top down’ EASA assumptions

- supported by:
  - **EAAMIRG activities**
  - **WG webex’s**
  - **Industry WG/SDO activities**
  - **developing EASA AM CM-S-008 revision**
  - **EASA AM WG (internal EASA)**

EASA efforts since 2023 Event primarily focused upon:

- EAAMIRG
- CM-S-008 revision

Further to the 2023 Event… industry requested Action: What is in service*?

*not necessarily the same as what has been taken to certification!

Two Actions*:

1/ ‘Snap Shot’ (for this 2024 Event) – What is in Service? (J. Von Weg, EASA):

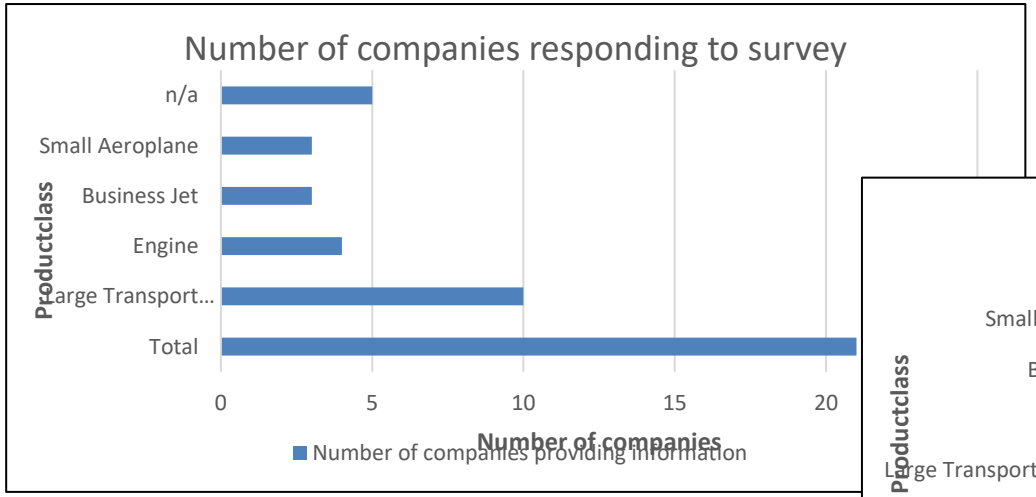
2/ Longer Term EASA Action – What is in Progress? (C. Caruso, A. Duranec, EASA)

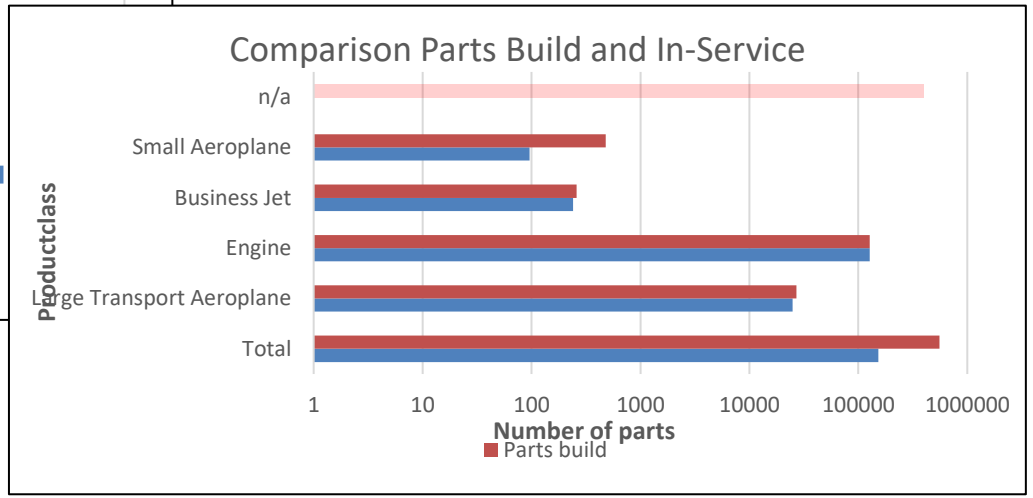
See later presentation for further information.

*note: need for further co-ordination between actions recognised

Further to the 2023 Event… industry requested Action: What is in service*?

1/ 'What is in Service ?





See later presentation for further information.

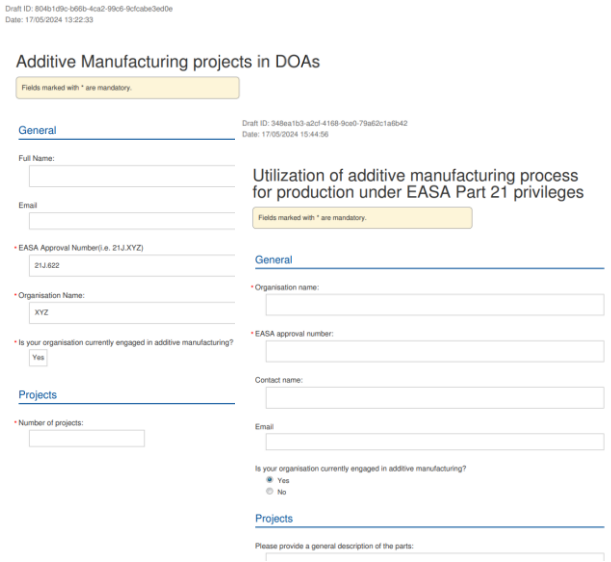
Further to the 2023 Event… EASA Action: What is being built and/or in development?

*not necessarily the same as what has been taken to certification!

2/ Longer Term EASA Action – What is in Progress?

EASA Design Organisation Approval (DOA) and Production Organisation Approval (POA) Forms (Drafts) developed (forms previously shared with industry, to be combined as one form)

- intended to be used to track existing and developing DOA and POA activities
- 'longer term' action – if so how long (new technology introduction!)?
    - organisation's IP to be respected
    - need for anonymous information summary/broader sharing?
        - acceptable to contributors?
        - if so, how?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Additive Manufacturing projects in DOAs

Fields marked with * are mandatory.

General

Full Name:

Email

* EASA Approval Number(i.e. 21J.XYZ)

21J.622

* Organisation Name:

XYZ

* Is your organisation currently engaged in additive manufacturing?

Yes

Projects

* Number of projects:

Draft ID: 348ea1b3-a2cf-4168-9ce0-79a62c1a6b42
Date: 17/05/2024 15:44:56

Utilization of additive manufacturing process for production under EASA Part 21 privileges

Fields marked with * are mandatory.

General

* Organisation name:

* EASA approval number:

Contact name:

Email

Is your organisation currently engaged in additive manufacturing?

Yes

No

Projects

Please provide a general description of the parts:

EASA - AM

EASA Update 2024:

1/ 2023 EASA FAA AM Event Reminder

2/ Advanced Materials and Processes - Developing Rulemaking and Guidance

- CS25 amdt.27 – AMC 25.603 & 605 revision (reminder)
- EASA AM CM-S-008 ‘Additive Manufacturing’ revision CRD to be discussed in WG1

3/ European Aviation AM Industry Regulator Group (EAAMIRG)

- brief update since 2023
- EAAMIRG Action 2 ‘Standards and the Use of Standards’(Richard Mellor - Rolls Royce)

EASA - AM

Reminder: CS25 amdt.27 – AMC 25.603, 605, and 613 revision.

- **AMC 25.603, 605, 613 updated to better reflect more recent integrated AMP technology** considerations, when 'engineering properties' are defined in final complex part configuration production process, e.g. emphasise use of the test/analysis pyramid etc

EASA intent:

- **carry 'similar' text into other product CS's, e.g. CS27,29, CS-E, CS-P etc**

and/or

- **develop common AMC 20-XX 'Advanced Manufacturing'** (e.g. AMC 20-29 'Composite Materials' could become a section of this document, in conjunction with 'Advanced Alloys, Metallic AM, Non-metallic AM etc)

- aligned with EAAMIRG activities
- possible EAAMIRG Action – consider need to revise/harmonise CS/FAR25.613 and guidance material?

EASA - AM

Reminder: EASA AM CM-S-008 'Additive Manufacturing' revision CRD to be discussed in WG1

Revision to issue 4 to include changes relating to the following:

(draft revision shared with industry for comment during 2024, closed for comment 6th June 2024):

- '**criticality classification**'
- '**certification demonstration effort being proportionate to criticality**' (WG1 'no and low' criticality, particularly non-TCH applications)
- increased emphasis upon '**Safety Assessments**', e.g. FHAs, FMECA, or RASs (WG1 'no and low' criticality, particularly non-TCH applications)
- addition of AM parts of 'no or low' criticality '**Examples**'
- updates references

- aligned with '**step by step' approach relative to 'criticality'**, and EAAMIRG Action Items
- represents real current industry certification activities
- this amendment driven by WG1 activities

WG1 activities for this 2024 meeting:

- review Comments Response Document (CRD) EASA response summary
- AIA 'MRO' and 'Increasing Criticality' document presentations
- NADCAP 'Findings' summary and future plans presentation
- combined meeting with new WG4?

EASA - AM

EASA Update 2024:

1/ 2023 EASA FAA AM Event Reminder

2/ Advanced Materials and Processes - Developing Rulemaking and Guidance

- CS25 amdt.27 – AMC 25.603 & 605 revision (reminder)
- EASA AM CM-S-008 ‘Additive Manufacturing’ revision CRD to be discussed in WG1

3/ European Aviation AM Industry Regulator Group (EAAMIRG)

- brief update since 2023
- EAAMIRG Action 2 ‘Standards and the Use of Standards’(Richard Mellor - Rolls Royce)

European Aviation AM Industry Regulator Group (EAAMIRG)

EAAMIRG – Summary

Scope/Mission:

- define European Aviation AM interests and priorities
  - safe and efficient AM design, production, in-service utilisation, and certification
- work constructively with other AM groups, e.g. AIA
  - recognising need for harmonisation in increasing complex global industry
  - avoid 'reinventing the wheel'

Organisations initially involved European TCHs, 1st Tier suppliers, EASA, European NAAs

- meetings (approx. 3 per year)

EAAMIRG – **Industry** and EU Regulator membership:

- **Airbus – Commercial**
- **Airbus – Defence and Space**
- **Airbus – Helicopters**
- **Boeing***
- **BAZL** (Switzerland)
- **CAA UK***
- **Dassault**
- **DGA (France)**
- **EASA**
- **FAA***
- **GE***
- **GKN**
- **ITP**
- **LBA** (Germany)
- **Liebherr**
- **MTU**
- **Rolls Royce**
- **Safran**
- **TCCA* (2022)**
- **Thales**
- **Traficom** (Finland)

2022:
- new members
- recognise need to engage with MROs etc (see MRO theme at this Event + WG1 activities)
- increasing EAAMIRG applications of increasing criticality

* non-EU 'associate members' invited to **support harmonisation intent**

European Aviation AM Industry Regulator Group (EAAMIRG)

EAAMIRG Activities:

- support **revision to EASA CM-S-008 issue 3**

- identify **EAAMIRG priorities** (based upon priority matrix, and outputs from various workshops etc)

completed, but continuing support for WG 1, and CM
(note: see also ASTM F3572-22, 2024 introduction of WG4, 'criticality' v 'risk' discussion etc!)
'no/low criticality' theme

- **Part Classification and Authority Engagement** (LoI etc)
(**Airbus Lead** – John Van Doeselaar)
  - improve **standardisation of the 'criticality' determination process**
  - improve industry and regulator understanding of the subject
  (note: potential to support the CM 'Parts of No Criticality' discussion in user communities)

started, supporting WG1, WG2, WG 3, and CM*

- **Standardisation: understanding and use of 'standards'**
(**Rolls Royce Lead** – Richard Mellor, previously Neil Mantle)
  - **better understand and identify common 'good practices' when using standards** relative to
    - Criticality of application
    - organisation experience
    - organisational structure in the end to end product chain, e.g. large integrated organisations (including machine suppliers etc) v small organisations in extensive subcontractor chains

*See following presentation for further information.

European Aviation AM Industry Regulator Group (EAAMIRG)

EAAMIRG activities/potential activities identified since 2023 Event (further to points already mentioned):

- **review EAAMIRG priorities/actions** (update 2019 process). Possible new actions include (To Be Determined):
  - 2x.613 harmonisation/revision
  - revise 2x.619 (broader than AM activity)
  - review relevance of 2x.621 'Castings' to AM (see also WG4?). Note:
    - Although 2x.621 is an interpretation of 2x.305, 307, 603, 605, 571, etc, 1529 etc, what was the (statistical?) link between test types, test numbers, inspections and criticality?
    - Can this be adapted to AM?
    - Is there any benefit relative to simply following the 2x.305, 307, 603, 605, 571, etc, 1529 etc for each M&P and configuration (as we do for composites, but supported by base pyramid shared databases, e.g. NCAMP)?
  - develop IPM (link to WG3)
  - develop co-ordination with MRO (and interiors) AM activities, noting that current/near term applications are typically associated with 'repair by replacement' (link to WG1, WG4, and AIA MRO paper)
  - develop AM, and proportionate MoC, in more critical applications (link to WG1, WG2, WG3, and WG4, also future CM-S-008 revisions, AIA Paper etc)

- **develop an anonymous AM 'lessons learned' database,** e.g. including elements from NADCAP, Rotor Integrity Steering Committee (RISC) strategies etc? To be co-ordinated with NIAR related activity planned?

Reminder: EASA AM WG (internal to EASA/Industry Contacts)

Note: now expanded beyond Additive Manufacturing, to be EASA Advanced Materials and Processes (AMPs) WG

Reminder: Initial EASA AM product or discipline contacts (per draft CM-S-008 issue 4)

Materials	S. Waite	simon.waite@easa.europa.eu
Aircraft Structures	W. Hoffmann	wolfgang.hoffmann@easa.europa.eu
Propulsion (Engines, Propellers & APU)	O. Kastanis M. Mercy*	omiros.kastanis@easa.europa.eu matthew.mercy@easa.europa.eu
Cabin Safety	T. Ohnimus F. Negri	thomas.ohnimus@easa.europa.eu fabrizio.negri@easa.europa.eu
Systems	M. Weiler	michael.weiler@easa.europa.eu
Design Organisation Approvals	C. Caruso A. Enache*	claudio.caruso@easa.europa.eu alexandru.enache@easa.europa.eu
Production Organisation Approvals	A. Duranec	ana-marija.duranec@easa.europa.eu
Maintenance Organisation Approvals	R. Tajes	rosa.tajes@easa.europa.eu

*original EASA contact addressing theme

Note: Please also cc Jonas Vom Weg (JONAS.VOMWEG@easa.europa.eu) if contacting Simon Waite)

EASA
European Union Aviation Safety Agency

Federal Aviation Administration

QUESTIONS?

EASA
European Union Aviation Safety Agency

Federal Aviation Administration

Support Slides

EASA - AM

FAA EASA AM Event - WG1 Breakout Agenda:

17th Sept (13:30-16:05hrs approx. 2hrs 35mins): **WG1**

- introduction/EASA CM-S-008 Revision Process reminder (since issue 3 release 30th April 2021)
- start CM CRD/CM Final Text Review (main points)

18th Sept (13:40-16:50hrs, approx. 3hrs 10mins): **WG1 + WG4**

- AIA 'MRO' document review (Drew Korte F2F (Delta Airlines), Eric Sager Virtual (Boeing) - 30 mins + Qs)
- AIA 'More Critical Applications' document (Morgan Mader F2F (Joby) - 30 mins + Qs)
- NADCAP Audit – Findings Summary (Richard Freeman F2F (PRI) – 25 mins)
    - Brief overview of Nadcap programme
    - Audits to date in metallic powder bed fusion AM and types of NCRs found in audits
    - Development of DED AM Audit Criteria
    - Plans for Audit Criteria for non-metallic AM processes
    - Audit Criteria for the manufacture of metallic powder for AM
    - Q&A/discussion time
- CM CRD/CM Final Text Review (brief) Summary (Simon)
- WG4 discussion slides (Mark)

19th Sept (08:20-10:00 hrs approx. 1hr 40 mins + Debrief): **WG1+WG4**

- continue CM CRD/CM Final Text Review?
- future WG1 and CM revision activities (Simon), FAA (Cindy) etc (WG1 - please be prepared to discuss)?
- WG1 Summary debrief (icw WG4 for combined Summary (+ 20 mins))

EASA – Regulatory Framework and Change

EASA resources and priorities:

EASA Level of Involvement (LoI): PART21.100: (Opinion 07/2016 + NPA 2017-20, now published)

- **priority is safety… 'do not reduce the existing accepted level of safety'**
- **prioritise activities with respect to novelty, criticality, complexity**

New materials, processes, configurations, analytical tools etc

Proportionate Means of Compliance expected

EASA move towards 'Performance' Based Regulations' (PBR*), i.e. less prescriptive

e.g. CS23 'General Aviation…' amdt.4 to amdt.5

- **flexibility benefit for industry technology progress… and potential safety benefits…**

  ….but need for a 'level playing field' remains (new organisations?)
- **standardisation organisations and shared industry databases becoming increasingly important**

Not only materials databases, but shared analytical method/tool databases?

Note: PBR has been, and is being, applied to other industries, so there may be some useful 'lessons learned' for aviation (see the Food and Drug Administration presentation EASA FAA AM Event 2021 WG)

*https://www.easa.europa.eu/sites/default/files/dfu/Report%20A%20Harmonised%20European%20Approach%20to%20a%20Performance%20Based%20Environment.pdf

Modelling and Simulation - Materials

Modelling and Simulation considerations (at all levels):

Main 'Attention Items' for M&S:

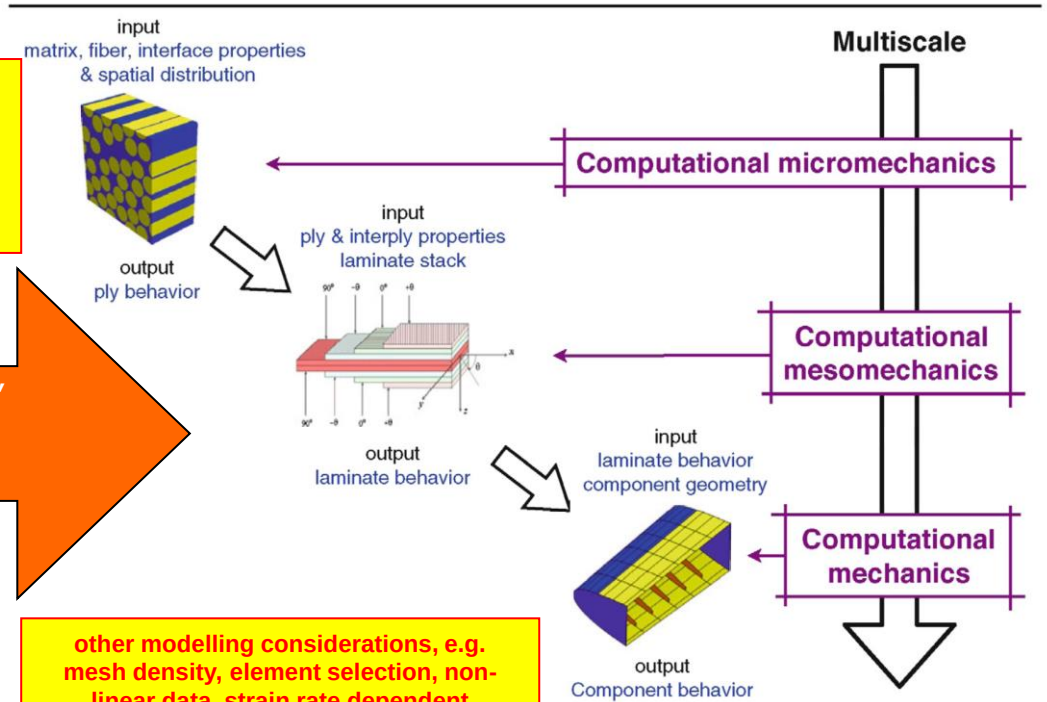
- *Verification*
- *Validation*
- *Errors & Uncertainties*
- *Extrapolation*
- *Documentation*
- *Experience*

Representative?

Correct failure modes?

Design v Certification needs?

'Attention Items' to be considered at all levels?



W. Doeland Notes 21/10/19

other modelling considerations, e.g. mesh density, element selection, non-linear data, strain rate dependent properties, hour glassing,

…other AC 20-146 issues etc?

"'Certification by Analysis', or Modelling & Simulation" W. Doeland Workshop on Modelling & Simulation, Koeln, 29/30 August 2019

EASA – Regulatory Framework and change

The Regulations – EASA priorities and resources:

applies to baseline structures, **changes, and repairs**

safety is the priority…

'change should not reduce the existing acceptable level of safety'

Based upon:

- experience
- reaction to incidents and accidents
- R&D
- 'engineering judgement'
- regulations existing at the time of certification
- Type Certificate Holder (TCH) in-house design pra[illegible]ces

Design with a 'robust' design concept
(beyond scope of detailed 'threat assessment')

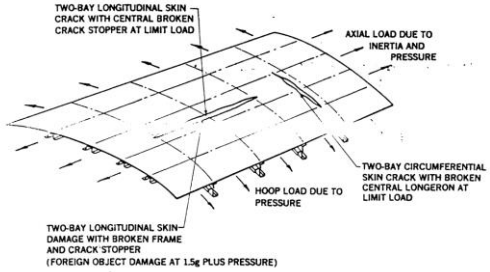


FIGURE 2. FUSELAGE DAMAGE TOLERANCE SIZES FOR STRUCTURAL DESIGN

e.g. Design for Redundant Structures …Tom Swift
For conventional metals, a cracked frame and 2 cracked frame bay skins

Note: part of broader 'test v analysis' issue relating to new technology, equivalence, and existing 'acceptable' level of safety – divergent situation… wish to replace test with analysis versus increased complexity and competing failure modes?