EASA
European Union Aviation Safety Agency

Federal Aviation Administration

EASA – Structures and Materials Safety

EASA – FAA AM

INDUSTRY – REGULATOR EVENT

(virtual meeting)

WORKING GROUPS – INTRODUCTIONS, UPDATES, MEETING PROCESS

November 8-12/11/2021

S.Waite, Senior Expert – Materials, Certification Directorate, EASA
M.Gorelik, Chief Scientific and Technical Advisor – Fatigue and Damage Tolerance, FAA

Your safety is our mission.

EASA - AM

Agenda outline (total 3 - 4hrs per day, starting 15:30hrs CET)

Day 1 (Monday, November 8)

- Welcome (Rachel Daeschler - EASA Certification Directorate Director)
- Regulators (EASA, FAA) – Opening Remarks/Update
- **Keynote Speech**: (Loris Molent (DTSO (retired)) 'Thoughts on Fatigue Certification of Metal Additive Manufacturing for Aircraft Structures'
- Industry (EAAMIRG) – Opening Remarks/Update
- Working Group (WG) 1, 2, and 3 update and process introduction

Day 2 (Tuesday, November 9)

- Presentations (preparation for Wednesday Sessions)
  - Performance based regulation
  - AM Modelling/Simulation (3 presentations)
- WG Parallel breakout sessions

EASA - AM

Agenda outline (total 3 - 4hrs per day, starting 15:30hrs CET)

Day 3 (Wednesday, November 10)

- Performance based regulation and the SDOs
  - Co-ordination / Collaboration across the SDOs
  - Data generation / databases / guidelines
- AM Modelling/Simulation (Mini Workshop - presentations and discussions):

Day 4 (Thursday, November 11)

- WG Parallel breakout sessions (continued from Day 2)

Day 5 (Friday, November 12)

- Technical presentations (3 presentations)
- WG debriefs
- Authorities panel
- Wrap-up

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Working Groups building upon previous meeting WG activities:

WG1: Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products)

Co-chairs: Simon Waite (EASA), Mitch Rife (Delta), Omiros Kastanis (EASA)

WG2: Fatigue and Damage Tolerance (F&DT) and Non-Destructive Inspection (NDI) Considerations for Metal AM

Co-chairs: Michael Gorelik (FAA), Andreas Fischerworrings-Bunk (MTU)

WG3: AM Machine Makers and End Users – Key Process Parameters (KPPs), Qualification, Requalification, and the Ideal 'End State'

Co-chairs: Richard Mellor (Rolls Royce), Don Godfrey (SLM)

- WG1 and WG2 – direct development from 2020 Event WGs
- WG3 – re-defined WG intended to address some more focused aspects of 2020 Event WG3 themes

Reminder: this Event is a milestone for these WGs, not necessarily an end point. Intent is to continue with WG activities as long as is necessary to conclude with a useful output, e.g. potential content or framework for guidance or standards documentation.

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WGs - Development since 2020 Event (details for each WG to be summarized by co-chairs):

- **Co-chairs and Core WG Teams identified and formed in early 2021**
- **preparation meetings completed during 2021**
- **define objectives and potential outcomes for the WGs and this Event,** see Agenda Outline: https://www.easa.europa.eu/newsroom-and-events/events/easa-faa-industry-regulator-am-event-0)
- **complete preparation specific for this Event** (presentations, share any preparation support to the broader group prior to the Event as considered necessary by Co-chairs of each WG etc)

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WG Process for this meeting (details for each WG to be summarized by co-chairs):

WG process for this Event :

- **attendees to use webex link identified for the WG selected during the registration process**
  (note: If you really need to change WG, then please contact Andrea or Phillip, details on EASA web site)
- **WG Co-chairs to define process for their meetings (Tuesday, and Thursday) and share this with the WG at the start of the Event meeting**
- **WG co-chairs to run the WG sessions**

WG Outputs for this Event :

- **Co-chairs and Core WG Team to develop summary of Event WG outcomes, including recommendations, for Friday de-brief** (Powerpoint bullet points, Excel Spreadsheet etc)
- **Co-chairs to provide 1-2 page written summary of Event WG outcomes for publication with the proceedings on the regulator web-sites**

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Questions?

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INDUSTRY – REGULATOR EVENT

(virtual meeting)

WORKING GROUP 1:

Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products)

November 8/11/2021

S.Waite, Senior Expert – Materials, Certification Directorate, EASA
O.Kastanis, Expert Propulsion, Certification Directorate, EASA
M.Rife, Delta TechOps, Interiors

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Day 2 (Tuesday, November 9)

- Presentations (preparation for Wednesday Sessions)
  - Performance based regulation
  - AM Modelling/Simulation (3 presentations)
- WG Parallel breakout sessions

- detailed WG1 preparation meeting 'catch-up' summary for expanded WG1 group (approx. 2hrs)

EASA - AM

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- Performance based regulation and the SDOs
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- AM Modelling/Simulation (Mini Workshop - presentations and discussions):

Day 4 (Thursday, November 11)

- WG Parallel breakout sessions (continued from Day 2)

- WG1 'WORKING MEETING' format (approx. 4hrs)

see slides and preparation spreadsheet previously shared with WG1

Day 5 (Friday, November 12)

- Technical presentations (3 presentations)
- WG debriefs
- Authorities panel
- Wrap-up

- WG1 Nov. 2021 summary and recommendations (20 mins)

EASA – AM WG1

Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products) – Background:

- **'proportionate' certification is not new**… an **established 'case by case' practice for some products of no/low criticality**, e.g. repair by replacement, using conventional methods, but little guidance or consistent documentation… and **typically not statistically rigorous**

- **ideally, manufacturing should not define 'criticality'** (should be material agnostic)

- new Advanced Materials and Processes (AMPs), e.g. AM, potentially introduce **new and competing failure modes, some difficult to detect, and greater variability** in some engineering property data

- **integrated complex parts** have potential to **impact several disciplines**, e.g. strength, functionality etc - structures-systems etc

- potential exists for an **Hazard Analysis to have not considered all possibilities if based upon conventional considerations for previous similar applications**, particularly for **those in small complex supply chains or not in the original TCH supply chain**

EASA – AM WG1

Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products) – Background:

- therefore, **potential exists for the manufacturing method to influence damage modes, sequences, variability, and safety outcome (aeroplane or pax level)… i.e. 'criticality'**

- furthermore, regulators are moving towards '**Performance**' Based Regulation, **increasing reliance upon other guidance processes**

- **WG1 Theme - Problem Statement:** In response to industry interest in the potential for a safe and viable business model for AM applications of no/low criticality, is there benefit from developing some more formalised regulator and/or industry 'level playing field' guidance regarding the approach to support determination of criticality and use of associated qualification processes?

- understanding 'criticality', see **EAAMIRG action 'Part Classification and Authority Engagement'**?
- need for **Functional Hazard Analysis (FHA)** thought process?
- use of standards, see **EAAMIRG action 'Standardisation: understanding and use of 'standards'**?

EASA – AM WG1

Working Groups building upon previous meeting WG activities:

WG1: Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products)

https://www.easa.europa.eu/newsroom-and-events/events/easa-faa-industry-regulator-am-event-0)

…The intent of this breakout session is to build upon initial 2020 Event discussions, including developing European Aviation AM Industry Regulator Group (EAAMIRG) Actions*, and further amendments to the recently released EASA AM CM-S-008 revision.
*EAAMIRG Actions, i.e. 'Part Classification and Authority Engagement' (LoI etc), 'Standardisation: understanding and use of 'standards'

The recent CM revision added content which may benefit from further discussion and development by interested parties, e.g. MROs, interiors organisations etc, relating to themes including:

- development of common industry standards regarding expectations for potential compliance data, e.g. statistics, testing etc., for parts of 'no criticality'
- simple common data presentation protocols for the purposes of certification of parts of 'no criticality'
- develop better understanding and definition of thresholds distinguishing parts of 'no criticality' from those of 'low criticality', including associated additional expectations for the latter, e.g. minimal supporting fatigue data, point design strategies etc

most likely tangible WG1 outputs associated with:

- **sharing of examples of certification or planned certification of parts of no or low criticality**
- **improved standardization and awareness of criticality** **(including need for better awareness/understanding of Failure Hazard Analysis/ development of simplified approach? etc)**
- **improved use of standards**
- **potential associated regulatory guidance development, e.g. CM revision, content for EASA CS-STAN etc**

EASA – AM WG1

Qualification of Additive Manufacturing (AM) Parts of No, or Low, Criticality (for use in Certified products) – Outline:

WG1 Scope: metallic and **non-metallic AM parts** (of no/low criticality), AM repairs (including repair by replacement), as applicable to a **range of products** (airframe, systems, cabin safety, propulsion etc)

Who is this for? - Decision makers, typically in the supply chain beyond Type Cert Holder:

Reminder: Decision makers/designers exist in a diverse range of organisations with a broad range of capabilities and experience supporting a broad range of approvals… impact upon safety may not be clear to some of these organisations

- Supplemental Type Cert Holders
- Design Organisation Approval (DOA) Holders supporting MROs etc, e.g. under minor change approval, provided all aspects of the change meet the requirements for minor classification.
- ETSO/TSOs
- PART 145 organisations interpreting PART 145 etc (for information - allows repair by replacement)
- Stakeholders new to aviation, e.g. AM Machine Manufacturers.
- Regulators (in order to help define a 'level playing field' for industry)

EASA – AM WG1

Changing technology… and supply chain knowledge management

Other relevant regulations and regulatory activities: support/awareness PART145 activities, e.g. Point145.A.42(b)(iii) , CAO.A.20(c) or M.A. 603(c)

FABRICATION OF PARTS FOR INSTALLATION

…(c) All necessary data to fabricate the part should be approved either by the Agency or the **type certificate (TC) holder**, or **Part 21 design organisation** approval holder, or **supplemental type certificate (STC) holder**.

… (g) Examples of fabrication within the scope of a Part-145 approval may include but are not limited to the following:

(1) fabrication of bushes, sleeves and shims;

(2) fabrication of secondary structural elements and skin panels;

(3) fabrication of control cables;

(4) fabrication of flexible and rigid pipes;

(5) fabrication of electrical cable looms and assemblies;

(6) formed or machined sheet metal panels for repairs.

- most potential benefit from WG1 activity?

All the above-mentioned fabricated parts should be in accordance with the data provided in the overhaul or repair manuals, modification schemes and service bulletins, drawings, or should be otherwise approved by the competent authority.

EASA – AM WG1

WGs - Development since 2020 Event :

- **Co-chairs and Core WG Teams identified and formed in early 2021**

WG1: Core Team:

- **grew significantly* from initial 10-12 people to 50+ people throughout preparation meetings***
  (e.g. airframe, systems, propulsion, interiors (including seats), see support slides for list of those involved in WG1 preparation)

***'Criticality' discussions** (supported by EAAMIRG action item 'Part Classification and Authority Engagement') **indicated some commonality across product and technologies, but required input from all interested parties. Therefore, team expanded accordingly to ensure appropriate inputs**

- **WG1 objectives and priorities defined, see following slide**
- **need for tangible outputs recognized, e.g. EASA AM CM revision and/or content for SDO documents etc**
- **most likely tangible outputs identified 'Criticality' and 'Examples' content**
- **'Working Meetings' completing coverage of 'criticality' and 'examples' issues – need to develop elements into tangible output (CM revision content?, SDO document content? TBD)**

*** WG1 preparation meetings held: 29th April 2021, 27th May 2021, 16th September, 13th October 2021**
(typically 30-40 people per meeting)

EASA – AM WG1

WG1 – Meeting process:

86+ WG1 people registered

- **attendees to use webex link identified for the WG selected during the registration process (Tuesday and Thursday)**

WG1 DRAFT AGENDA - Tuesday (approx. 2hrs):

- **Co-chairs - process reminder from Monday** (Simon Waite, EASA - 5 mins)
- **Co-chairs – WG1 Introduction/Catch-Up slides (WG1 preparation 'Working Meeting' discussions)** (Simon Waite, EASA - 15 mins)
- **'Criticality' – developing discussion ASTM F42/EAAMIRG – WG1 Aspects** (Charles Park, John Van Airbus Boeing – 15 mins)
- **Potential Scaled Criticality/Degree of Rigor Certification Guidance** (Cindy Ashforth, Linda Jahner, FAA – 20 mins)
- **Selected Examples** (10 mins each):
  - **Structure:** GKN – Nacelle Access Panel Hinges (structure – propulsion) (Jean Luc Belon, Mark Bosman, Chris Dordlofva)
  - **Systems:** LIEBHERR - NLG Sensor Bracket (system - structure) (Andrea Danzig)
  - **Interiors:** MATERIALISE – Dado Panel (interiors) (Erik deZeeuw, Gert Brabants)/Expleo (Konrad Lehmann, Henryk Bork)
  - **Interiors – Seats:** SAFRAN – Interiors Seat Parts (interiors) (Muhammad Khan, Mehdi. Bolaky)
  - **Propulsion:** Title TBD (system – propulsion) (Jan Nelle, Rob Van den Bosch)
  - **Propulsion:** SAFRAN – Compliance Strategy To CS-E 510 (application to AM parts) (system-propulsion) (Hacene Cherouali)

EASA – AM WG1

WG1 DRAFT AGENDA - Thursday (approx. 4hrs):

- **Potential no/low criticality guidance - Simple Content Outline/Content** (Simon Waite, EASA – 5 mins)
- **FHA/RAS** (simplified - certification proportionality) (Michael Weiler, Simon Waite, EASA – 10 mins)
  - need to consider more than the part, but the broader system/functionality and safety outcome
- **SAE AM SEATS** (Thomas Rees-Gralton, Safran – 10-15 mins)
- **Other developing related draft SAE documents** (Roger Eybel, Safran Landing Systems - 10-15 mins)
  - step through content with no/low criticality in mind
  - **ARP 7041 'Standard Practice for Production, Distribution, and Procurement of Additively Manufactured (AM) Parts/Preforms'**
  - **ARP 7042 'Recommended Practice: Development Planning for Design of Additive Manufactured Components in an Aircraft System'**
  - **ARP 7043 'Additive Manufacturing (AM) Checklist for Designing/Repairing Aircraft Components that were developed from an ARP 7042**
- **SAE AM-Repairs** (Dave Abbot, GE – 10-15 mins)

- **STEP THROUGH SLIDES and SPREADSHEET – see email shared with WG1 prior to this meeting (WG1)**

EASA – AM WG1

WG1 – Meeting process: Please use previously shared slides and spreadsheet to prepare for meeting.

WG1 No/Low Criticality AM DOCUMENT DEVELOPMENT - OUTLINE AND CONTENT THEMES

VERY SIMPLIFIED CONTENT INTENDED

Please co-ordinate with attached slides

Please:
respond to questions
add bullet point themes considered worthy of document content

Slide	Questions	y	n	Other comments/suggestions
1	AM no/low criticality document content to follow AMC 20-29/AC 20-107B format?	?	?	
	If not, propose alternative (other SDO document format etc)			?
	Do you agree that no/low criticality can be managed under a common document for airframe, systems, propulsion, interiors (including seats?)	?	?	
	If not, propose alternative			?
	Do you agree that no/low criticality items would benefit from a separate industry document supporting regulatory intent?	?	?	
	If not, propose alternative			?

PLEASE RETURN COMPLETED WG1 SPREADSHEET TO S. Waite

by Friday 19th November 2021

EASA – AM WG1

WG1 – Meeting process:

Friday:

- **WG1 outcomes (Powerpoint),**
  - **bullet points from meeting**
  - **recommendations for**
    - **WG1 progress**
    - **development of guidance content, e.g. SDO documents and/or CM revision**
- **Co-chairs to provide 1-2 page written summary of Event WG outcomes within 2 weeks of the end of this Event for publication with the proceedings on the regulator web-sites**

PLEASE RETURN COMPLETED WG1 SPREADSHEET TO S. Waite

by Friday 19th November 2021

EASA – AM WG1 Core Team

(up to 13/10/21)

Aerolytics	Bihlman	Bill
Airbus	Van Doeselaar	John
AirFrance	Becel	Frederic
AirFrance	Bodin	Erik
AVIO	Palumbo	Andrea
Boeing	Park	Charles
Boeing	Kistler	Laura
Delta	Rife	Mitch
Delta	Mallory	Jaik
EAAMIRG		
EASA	Waite	Simon
EASA	Ohnimus	Thomas
EASA	Negri	Fabrizio
EASA	Weiler	Michael
EASA	Kastanis	Omiros
Expleo	Lehmann	Konrad
FAA	Grant	Robert
FAA	Jahner	Linda
FAA	Kerman	Daniel
FAA	Ashforth	Cindy
Fokker	Bosman	Marko
GE	Abbott	Dave
GE	Abbott	Dave
GKN	Dordlofva	Christo
GKN	Belon	Jean-Luc
ITP	Unanue	Iker
KLM	Tol	Gerard
LHT	Steven	Simon
LHT	Van Den Bosch	Robert
LHT	Hochheimer	Matthias
LHT	Nelle	Jan
Liebherr	Larat	Antoine
Liebherr	Danzig	Andrea
LTS	Larat	Antoine

Markforged	Burd	Tripp
Markforged	Mcguffin	Chloe
Materialise	de Zeeuw	Erik
Materialise	Bradants	Gert
MOOG	Jones	Jason
MOOG	Guerrier	Paul
NASA	Cordner	Sam
NASA GSFC	Glendening	Andrew
NASA KSC-C104	Russsell	Richard
NGC	Barnes	Eric
NIAR/SAE AM-P	Andrulonis	Rachael
NIAR/SAE AM-P	Lovingfoss	Royal
NIAR/SAE AM-P	White	Joel
SAE	Alexander	David
Safran	Thenaise	Anne
Safran	Cherouali	Hacene
Safran	Khan	Muhammad
Safran	Ridoosz	Lionel
Safran	Ree-Gralton	Thomas
Safran	Bolaky	Mehdi
Safran	Lemaire	Bruno
Safran	Eybel	Roger
Safran	Danis	Yann
Safran (HE)	Formentin	Jean-Francois
Safran (Safran Seats)	Ridoosz	Lionel
ST Aerospace	Lui	Evelyn
ST Aerospace	Zheng	Guoying
Stratasys	Fullen	Mark
Thales	Catt	Steven
Thales	Schneeberger	Danny
Thales	Eloi	Pierre
Ultimaker	Betty	Brian
Ultimaker	Kuiper	Paul
US Navy	Thorn	Kate

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Support Slides

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