

EASA – Structures and Materials Safety

EASA – FAA AM

INDUSTRY – REGULATOR EVENT

(virtual meeting)

WORKING GROUP 1:

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

Summary

S.Waite, Senior Expert – Materials, Certification Directorate, EASA

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M. Rife, Delta TechOps, Interiors

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‘Working Meeting’ – Objective:

In response to industry interest in AM parts of no/low criticality*, start to define:

- need for regulator and/or industry guidance documents*
 - potential content outline
 - potential location for documents

Note: Much of this discussion is **material and process agnostic**. However, in order to minimise the potential for manufacturing sensitivity to adversely impact ‘criticality’, e.g. due to changed/competing failure modes etc, such document content may be beneficial for AM, and other Advanced Material and Processes (AMPs), to be accepted... TBD

*

- understanding ‘criticality’, see EAAMIRG action ‘Part Classification and Authority Engagement’
- use of standards, see EAAMIRG action ‘Standardisation: understanding and use of ‘standards’?

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Tuesday:

- **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) (Andre Danzig)
 - **Interiors:** MATERIALISE – Dado Panel (interiors) (Erik deZeeuw, Gert Brabants)/Expleo (Konrad Lehmann, Henryk Bork)
 - **Propulsion:** Title TBD (system – propulsion) (Jan Nelle, Rob Van den Bosch)

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WG1 – Meeting process:

Thursday: 'Working Meeting' process - Potential Guidance Content and Location

- **Catch-up: missed 'Examples' presentations from Tuesday due to rescheduling:**
 - **Interiors – Seats:** SAFRAN – Interiors Seat Parts (interiors) (Muhammad Khan, Mehdi. Bolaky)
 - **Interiors:** AIRFRANCE: (F. Becel, E. Bodin) - Poetntial Examples of no criticality
 - **Propulsion:** SAFRAN – Compliance Strategy To CS-E 510 (application to AM parts) (system-propulsion) (Hacene Cherouali)

- **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)

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

WG1 No/Low Criticality AM DOCUMENT DEVELOPMENT - OUTLINE AND CONTENT THEMES				
VERY SIMPLIFIED CONTENT INTENDED			Please: respond to questions add bullet point themes considered worthy of document content	
Please co-ordinate with attached slides				
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**

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WG1 Summary/Progress 2020 - 2021:

- majority of agenda addressed (thanks for flexibility following Event agenda changes)
- time limited progress stepping through the slide and spreadsheet package. However, intent of the first 20 slides was addressed through discussing the examples
- discussing examples seemed to provide the most constructive approach to addressing understanding of criticality* and Means of Compliance (MoC)

* technical/safety issue, not to be confused with Major or Minor classification, which is used to determine the approval support route (see support slides)

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WG1 Summary/Progress 2020 - 2021: Understood to be verbally agreed within WG1 (subject to spreadsheet return confirmation)

- need for guidance confirmed, probably both regulator and industry guidance
(note: example of guidance document balance change as ‘performance’ based regulation is adopted)
- Scope of document intent agreed:
 - 1 and 2. Purpose and Objective:**
To provide safe, and practical, industry ‘level playing field’ guidance and to document good common practice relating to AM ‘parts of no/low criticality’

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WG1 Summary/Progress 2020 - 2021: Understood to be verbally agreed within WG1 (subject to spreadsheet return confirmation)

Applicability of document intent agreed:

3. Applicability:

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)

Primary consideration/benefit for:

- 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
- small organisations in complex supply chains
- regulators (in order to help define a 'level playing field' for industry)

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WG1 Summary/Progress 2020 - 2021: Understood to be verbally agreed within WG1 (subject to spreadsheet return confirmation)

- **F42/EAAMIRG ‘Criticality’ Classification work considered useful to WG1:**
(note: interiors input to be added)

Application	Categorisation from Critical -> Less critical				
Structures and system installation		Fatigue critical Parts	Fatigue sized parts	Static sized parts	Non loaded-remaining parts
	Examples:	PSEs	non-PSE primary structure sized by fatigue	Mainly secondary structure parts sized by static	Remaining secondary structure parts

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WG1 Summary/Progress 2020 - 2021: Understood to be verbally agreed within WG1 (subject to spreadsheet return confirmation)

- **Composite Modifications Document work** (matrix and associated proposed MoC approaches) **considered useful to WG1:**

SAE Draft Standard for Composite Modifications

Criticality	Material Control	Process Control	Design Values	Static Strength	F&DT	Flammability
1. High – parts whose failure directly affects continued safe flight and landing	X	X	X	X	X	As Required
2. Medium-High – parts whose failure indirectly affects continued safe flight and landing	X	X	X	S	S	As Required
3. Medium-Low – (1) structure whose failure does not affect continued safe flight and landing and (2) parts whose failure can affect passengers and crew	S	S	S	S	N	As Required
4. Low – all other parts	S	S	S, As Required	S, As Required	N	N

Notes:

- May need other columns/categories for engine regulations
- X = “full” compliance, S = simplified compliance, N = compliance not applicable
- Simplified methods of compliance are not the same between the levels

November 9, 2021

AM Parts with Low or No Criticality



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- **considered worth addition work to correlate F42/EAAMIRG work with the Composite Mod work**
- to be supported by cross product and discipline simplified FHA (possibly FMEA/RAS), particularly being based upon qualitative aspects
- **this could be the transition point between a regulator guidance document (EASA CM?, FAA PS etc) and industry documents**

Note: regulator interiors input yet to be determined

- industry to develop documents supporting ‘Simplified Compliance’ boxes... **including AM content**
- to be supported by documented examples for all product types
- caveats will be necessary for various products, e.g. some engine shut downs are minor, whilst others are not (e.g. debris escape events etc), requiring FHA/FMEA/RAS consideration in classification

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- Note: Examples Classification Discussion ‘No’ versus ‘Low’ criticality definition:
 - need for distinction between these...

e.g. consider ‘No’ criticality? due to:
- reference to existing material databases?
- simplified FHA/FMEA/RAS?

Low Criticality Parts

Criticality	Material Control	Process Control	Design Values	Static Strength	F&DT	Flammability
4. Low – all other parts	S	S	S, As Required	S, As Required	N	N

Examples of ‘No’ criticality: Simple small flat interior Panel

- some work required
- small item, > 12 inches separation from similar parts, ULTEM 9085,

Note: generally agreed:
- ‘S’ basis expectation, minimum,
- this level of data is captured through selection processes etc

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- Note: Examples Classification Discussion ‘No’ versus ‘Low’ criticality definition:
 - location/format for industry content?

Examples, add to (appendix?):

- higher level developing design document (metallic/non-metallic, across products etc) draft SAE ARP 7042, 7043 etc?
- higher criticality metallic AM document, e.g. SAE AM-R
- other?
- discussion started, TBD

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WG1: Actions beyond this Event:

- process returns from slides and spreadsheet and include in 2 page summary to be published with the meeting proceedings
- organise following WG1 meetings
- continue to develop points in previous slides
- 2022 – start revision to CM (tangible output) to account for regulatory guidance aspects of the points in previous slides (and WG3 output, as appropriate), if no location for content is found

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Questions?

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Support Slides?

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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

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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 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’?

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Reminder: 21.A.91 Classification of changes to a type certificate (TC)

‘Changes to a type-certificate are classified as minor and major. A “minor change” has no appreciable effect on the mass, balance, structural strength, reliability, operational characteristics, operational suitability data, or other characteristics affecting the airworthiness of the product or its environmental characteristics. Without prejudice to point 21.A.19, all other changes are “major changes” under this Subpart. Major and minor changes shall be approved in accordance with points 21.A.95 or 21.A.97, as appropriate, and shall be adequately identified.’

GM 21.A.91 Classification of changes to a type certificate (TC)

1. PURPOSE OF CLASSIFICATION

‘Classification of changes to a type certificate (TC) into MAJOR or MINOR is to determine the approval route...’

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GM 21.A.91 Classification of changes to a type certificate (TC)

3.4 Complementary guidance for classification of changes

A change to the TC is judged to have an **'appreciable effect'** on the mass, balance, **structural strength, reliability, operational characteristics... airworthiness etc**

- (a) ... requires an adjustment of the type-certification basis or the OSD certification basis (special conditions or equivalent safety findings)
- (b) ...new interpretation of the certification specifications used for the type certification basis or the OSD not been published as AMC material or otherwise agreed with the Agency;
- (c) ...**compliance uses methods that have not been previously accepted as appropriate for the nature of the change**
- (d) ... **extent of new substantiation data necessary to comply with the applicable certification specifications and the degree to which the original substantiation data has to be re-assessed and re-evaluated is considerable;**
- (e) ...alters the airworthiness limitations or the operating limitations;
- (f) where the change is made mandatory by an airworthiness directive or the change is the terminating action of an airworthiness directive (ref. [21.A.3B](#)), see Note 1; and
- (g) ... **design change introduces or affects functions where the failure effect is classified as catastrophic or hazardous.**

Note 1: A change previously classified as minor and approved prior to the airworthiness directive issuance decision needs no reclassification. However, EASA retains the right to review the change and reclassify/reapprove it if found necessary.