

Comment				Comment summary	Suggested resolution	Comment is an observation (suggestion)	Comment is substantive (objection)	EASA comment disposition	EASA response
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1	Air France DOA EASA.21J.027	Regulatory requirement(s)	1	<p>The AM parts can also be installed in areas subjected to flammability requirements (i.e. compartment interiors).</p> <p>CS sections relating to fire protection (AM materials flammability behaviour) are not mentioned.</p> <p>This AM materials flammability characteristics seem also subject to variability.</p>	CS Sections-relating to fire protection (AM materials flammability behaviour) should be added (i.e. CS X.853, 855, 856, 869, ...).	Yes	No	Partially accepted	Comment added to section 3 of CM to reference flammability.
2	Safran Power Units	§2	4	<p>Original text :“ As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts.”</p> <p>Comment: Why considering AM material more process dependent? We considers that the forging and casting material characteristics processes are also process dependant.</p>	Replace by :“ As such, AM materials are process dependent like casting materials for example”		Objection	Partially accepted	See revised CM text.
3	Safran Power Units	§3	4	<p>Original text :“ The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval.”</p> <p>Comment:“ Not all repair using A. M. should be classified as major, and DOA privileges should apply when the material is known.</p> <p>Current 21.A.91 is deemed adequate as is for A.M. otherwise, this CM should define the specific criteria for part repair, using AM, classified as major”</p>	The use of AM in repair and repair design could be classified Major, applicants are therefore advised to consult the Agency when introducing AM in repairs		Objection	Partially accepted	See revised CM Policy text.
4	Safran Power Units	§3	4	<p>Original text :“ Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM.”</p> <p>Comments :“ we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research project are shared only when they are enough mature and representative. “</p>	Design Organisation Approval Holders are recommended to involve the Agency when AM implementation is decided.	Suggestion	No	Noted	No specific text change made.

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5	ECMS Aviation Systems GmbH			<p>ECMS Aviation Systems welcomes EASA's activities with respect to additive manufacturing (AM) by offering an accepted procedure to integrate AM into design and manufacturing.</p> <p>However, the CM lacks differentiation on parts complexity and criticality. AM may be used in producing a primary structure component of an airframe by metal laser sintering, or it may be used to 3d-print a stylish napkin holder with airline logo in cheap plastics extrusion. Both parts may be part of an airworthiness approval, STC etc., but play in entirely different leagues of complexity, safety and investigation depth.</p> <p>We would therefore ask EASA to enable a much simplified way by which parts of negligible safety relevance may be included in a design change without the overhead of, quote from the CM, being "subject to increased oversight by the agency and that specific audits will be scheduled to examine the introduction and use of AM within the scope of the design organisation audit cycle..", given that the AM component has no important function and strength requirement, and is not likely to cause a FOD situation upon failure.</p> <p>As "3d printing" in non-aviation industry is already a de-facto standard, this simplified way should include DO and PO, allowing for a simple and direct way of integrating AM in the design and production of non-safety relevant parts (the DO should of course be competent to judge parts criticality and safety standard requirements)</p> <p>Also, it may be helpful if the CM would generally address methods/procedures for development prototyping by AM for parts which may be manufactured by traditional methods in serial production (e.g. 3d printing for the prototype, injection molding for the serial part)</p>		Suggestion	No	Noted	The CM provides a first step in EASA AM guidance and is intended for type certification. Part criticality will, as always, be considered during certification and is reflected in the published CM.
6	Liebherr Aerospace Toulouse	Section 1.1	3	<p>For metallic material, the final properties are obtained after AM part post-treatment like heat treatment, surface finishing, ...</p> <p>For Non-metallic material, the final properties are obtained during fabrication process</p>	The unique feature of AM for Non-metallic materials is that their final mechanical properties are obtained during fabrication process and for metallic material the final mechanical properties are obtained after AM post treatment.	No	No	Noted	The proposal is not deemed necessary. It does not change the intent of the CM.
7	Liebherr Aerospace Toulouse	Section 1.1	3	For metallic material, post-treatments is also allows reduce the variability in the manufacturing process (like anisotropy following build axes)	As such, the data used to design no metallic AM parts must account not only the typical variability of the as-purchased material, but also for the variability seen in the manufacturing process. For metallic parts the data used to design parts must account also the post treatment impact on AM material	No	Yes	Noted	Component qualification should reflect the final product. No change has been made to the CM.

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8	Liebherr Aerospace Toulouse	Section 2	4	As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts.	Remove this sentence	Yes	No	Not accepted	See response to comment # 2.
9	Boeing Commercial Aeroplanes	Sec. 1.3	3	No definition to abbreviation "POA"	We suggest adding a definition to "POA - Production Organization Approval". The term POA is used in the document but not defined.	Yes	No	Accepted	CM has been amended accordingly.
10	Boeing Commercial Aeroplanes	Sec. 3, 2 nd paragraph	4	<p>3. EASA Certification Policy and Guidance for DOA and POA Holders</p> <p>...</p> <p><i>The applicant is requested to provide details to the Agency on how constituent materials are being purchased and on how the fabrication process is being controlled. In addition an applicant should provide a description of how testing being used to derive design values statistically accounts for the variability introduced in production by both the material and fabrication methods used.</i></p> <p>...</p>	<p>3. EASA Certification Policy and Guidance for DOA and POA Holders</p> <p>...</p> <p><i>The applicant is requested to provide details to the Agency on how constituent materials are being purchased and on how the fabrication process is being controlled. In addition an applicant should provide a description of how testing being used to derive design values statistically accounts for the variability introduced in production by both the material and fabrication methods used.</i></p> <p>We request this paragraph to be deleted.</p> <p><u>Justification:</u></p> <p>As is noted in the fourth paragraph of Section 3 on page 4 and the first paragraph at the top of page 5, both Design Organization Approval Holders and Production Organization Approval holders are advised to involve their respective regulatory agencies during the development and implementation of additive manufacturing processes. It is during this interaction with the regulatory agencies that each organization's proprietary material specifications, testing procedures, production processes, and applications will be reviewed and discussed. The individual organizations and their regulatory agencies will determine what data needs to be reviewed based on the specific application of additive manufacturing. The recommendations in both of these paragraphs for Design Organization Approval Holders and Production Organization Approval holders to coordinate with their regulatory agencies makes this paragraph redundant.</p>	No	Yes	Partially accepted	EASA considers that the CM provides a high level framework for the technical and process expectations during a certification programme.
11	Safran Helicopter Engines	§1.1	3	<p><i>"The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process."</i></p> <p>Comment : Why consider this as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.</p>	Like cast materials, AM material mechanical properties are substantially obtained during the fabrication <u>and post-fabrication operations</u> process.	No	Yes	Noted	See response to comment # 2.

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12	Safran Helicopter Engines	§1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification. The statistical basis of the design values must account for all sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design specification.</u>	Yes	No	Accepted	CM policy text has been revised to emphasise the importance of specifications and addressing machine to machine and site to site variability.
13	Safran Helicopter Engines	§1.1	3	<p><i>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation (including specimen testing).</u>	Yes	No	Accepted	See response to comment # 12.
14	Safran Helicopter Engines	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limit the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	The identified table has been amended within the CM text.

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15	Safran Helicopter Engines	§2	4	<p>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</p> <p>Comment : Why consider AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are more process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 2.
16	Safran Helicopter Engines	§3	4	<p>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</p> <p>Comment : As for any material, the Part 21.A.91 and its GM must be applied to the part using Additive Manufacturing process. However, not all repairs using AM should be classified as Major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as Major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<p>The use of AM in repair and repair design <u>should</u> be classified Major <u>when</u></p> <p><u>When</u> the use of AM in repair and repair design <u>is</u> classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.</p>	No	Yes	Partially accepted	<p>The CM does not challenge established and accepted practices. It addresses a potential step change in technology.</p> <p>The Cm has been revised to reflect that the use of AM in repairs and design changes may be classified major based upon the level of substantiation required and the suggestion to encourage consultation even when a privilege is held has been incorporated into the revised CM.</p>
17	Safran Helicopter Engines	§3	4	<p>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u> .	Suggestion	No	Noted	See response to comment # 4.

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18	Safran Helicopter Engines	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process, that includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place, ensuring that the POA holder will be aware of a CM applicable to a part he is manufacturing, in order to advise his respective competent authorities.</p>	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p>	No	Yes	Not accepted	<p>The CM provides general guidance within the field of AM implementation from a certification perspective.</p> <p>Requirements are in place regarding the DOA – POA interface, furthermore EASA and NAA's will communicate the guidance found in the CM to POA holders during the course of the POA oversight.</p>
19	Embraer	Section 1.1	3	<p>The applicability of the certification memo should be limited to AM components whose failure could contribute to catastrophic failure (CS 25.571) or adversely affect safety (CS 25.603). There are some applications of AM where the component serves no safety function (decorative panels, coat hooks, etc.) that should not require the rigorous substantiation outlined in the draft memo.</p>	<p>Embraer suggests that the second sentence of the third paragraph of Section 1.1 be modified to say "As such, in applications of AM where the failure of the part could contribute to a catastrophic failure or adversely affect safety, the data used to design AM parts must account for not only the typical variability of the as-purchased material, but also for the variability seen in the manufacturing process."</p>	Yes	No	Partially accepted	See comment # 5.
20	GE Avio	3. Impact of AM on Production Organizations	5	<p>Part 21.A.131 highlights the fact that applicable design data – when released in a controlled manner – “should be sufficient for the development of production data to enable repeatable manufacture to take place in conformity with the design data.” The use of AM processes cannot be decoupled from the requirements of part 21.A.131 to establish the required design data. A POA Holder producing parts for a DOA Holder cannot elect to introduce a change to an AM process from a different manufacturing process without the concurrence of the DOA Holder.</p>	<p>Revise the wording in this paragraph to make it clear that AM is controlled through the published design data requirements of 21.A.131 such that use of AM processes by POA holders does not necessarily represent a significant change in accordance with Part 21.A. 147.</p>	Yes		Accepted	The relevant section of the CM has been revised.
21	GE Avio	3. Impact of AM on Production Organizations	5	<p>POA Holders work with their competent authorities independent of the DOA Holders. As a result, POA Holders who use AM processes may not be aware of the recommendation in this CM to engage their competent authorities when introducing AM processes.</p>	<p>EASA needs to define a path that ensures that POA Holders are aware of the additional guidance contained in this CM.</p>	Yes		Partially accepted	See response to comment # 18.
22	Zodiac Aerospace	Section 1.1		<p>The term "final, mature production process" is not obvious.</p>	<p>Please add clear and distinctive criteria for "final, mature" vs. "approved production process"</p>	Suggestion	No	Partially accepted	The referenced phrase no longer exists in the revised CM text therefore no further clarification is required.

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23	Zodiac Aerospace	Section 2		The description of AM is not obvious (3D printing).	Please add a clear and distinctive definition of AM to assure a uniform application of this CM	Suggestion	No	Noted	EASA agrees that there are several definitions of AM which are yet to be standardised; applicants are therefore recommended, as identified in the CM to engage with EASA during AM implementation. Note, the purpose and scope has been amended to exclude existing established and accepted practises which may show some similarity to AM processes.
24	Zodiac Aerospace	Section 3		The term "approved" is used for material specification and production process specification.	Please add clear criteria for "approved", i.e. what kind of approval is required, by whom and how, i.e. identification of approval status (DOA under privileges as per 21.A.263(c)4)	Suggestion	No	Not accepted	The CM addresses AM practises and is not intended to address broader procedural terminology issues.
25	Zodiac Aerospace	Section 3		As per 21.A.435/21.A.91 the use of AM does not necessarily substantiate a Major classification, as an example AM is applied for a flap or table installed in a cabin interior like a galley.	Please add that the use of AM is classified Major for structural elements, such as spars, frames and critical parts, as stipulated in Appendix A 1.(ii) to GM 21.A.91.		Objection	Accepted	See response to comment # 3 and # 16.
26	GE Aviation	1.1 Third Paragraph	3	The first sentence of this paragraph states that AM is "unique" because "the final mechanical properties are obtained during the fabrication process." While it is true that the mechanical properties of AM parts are primarily "obtained during the fabrication process", this concept is not unique to AM. Casting represents another range of manufacturing processes where the mechanical properties are substantially established during the fabrication process. Post-fabrication operations such as heat treatments (including thermal cycles associated with brazing components together), hot isostatic pressing (HIP) and application of environmental and/or wear resistant coatings to AM parts also impact final part mechanical properties.	Revise this sentence to read: "Like cast materials, AM material mechanical properties are substantially obtained during the fabrication process." Add a reference to the potential impact of post-fabrication operations on final mechanical properties.	Yes	No	Partially accepted	See response to comment # 2.
27	GE Aviation	1.1 Third Paragraph	3	In the third sentence in this paragraph ... The phrase "their internal facilities" is too restrictive as "external facilities" are also likely to be used to produce parts via AM. In addition to multiple AM facilities, multiple AM machines within a given facility can also be a source of variation.	Revise this sentence to read as follows: "The applicant should show that the derived AM design values are based on data generated with production parameters and are sufficiently robust to capture machine-to-machine variation within and between facilities. The applicant should show that values obtained from tests conducted on simple specimens accurately represent mechanical properties for intended parts.	Yes	No	Accepted	The CM policy text has been revised to address the comment raised.

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28	GE Aviation	1.1 Third Paragraph	3	In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.	Add more content around the topic of specimen testing using “simple specimens”.	Yes	No	Accepted	The CM policy text has been revised to address the comment raised.
29	GE Aviation	1.2	3	In addition to the current reference to Part 21, Subpart M (Repairs), we believe this section should also reference Part 21, Subpart B (Type Certificates and Restricted Type Certificates), Part 21, Subpart D (Changes to Type Certificates and Restricted Type Certificates) [referenced in Section 3.] and Part 21, Subpart E (Supplemental Type Certificates).	Add references to : <ul style="list-style-type: none"> Part 21, Subpart B (Type Certificates and Restricted Type Certificates) Part 21, Subpart D (Changes to Type Certificates and Restricted Type Certificates) Part 21, Subpart E (Supplemental Type Certificates) Alternately, this section could simply reference Part 21 and not delineate subparts.	yes	no	Accepted	The CM has been revised see Table in section 1.2.
30	GE Aviation	2.	4	Fourth Sentence ... The phrase “more process dependent” can be a little misleading. As highlighted in comments to Section 1.1, in addition to AM there are other fabrication processes (e.g. casting processes) where the mechanical properties are substantially established during the fabrication process. GE believes the emphasis of this section should focus on the importance of properly characterizing the AM material and resultant mechanical properties rather than the uniqueness of AM processes.	Delete the fourth sentence in this paragraph. Alternately, revise this sentence to read as follows: “As such, the final characteristics and properties of parts manufactured using AM materials and techniques are highly dependent on manufacturing process control.”	Yes	No	Partially accepted	See response to comment # 2. The intent is reflected in the revised CM.
31	GE Aviation	2.	4	Fifth Sentence ... Section 1.1 uses the term “as-purchased material” while this sentence uses “constituent materials as purchased by the suppliers”. We recommend using a single term throughout this document.	Fifth Sentence ... Replace “constituent materials as purchase by the suppliers” with wording consistent with Section 1.1.	Suggestion	No	Accepted	The CM has been revised.
32	GE Aviation	2.	4	Last Sentence ... As highlighted in comments to Section 1.1, post-fabrication processing can have an impact on design values used for AM materials.	Last Sentence ... Add the phrase “including post processing operations” to the end of this sentence.	Suggestion	No	Accepted	The CM has been revised to also make reference to post process operations.
33	GE Aviation	3.	4	This section makes no mention of materials or process specifications.	Add a sentence where appropriate to highlight the fact that “Applicants should provide evidence that materials and processes are addressed by specifications and the specifications are under revision control.”	Suggestion	No	Accepted	The CM policy text has been revised to address the need for specifications.

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34	GE Aviation	3. First Paragraph	4	<p>The current focus of the last sentence is establishing design values based on assessment of both material variability (<i>assumed to be in reference to raw material</i>) and process variability, as well as any variability associated with fabricating parts at multiple facilities.</p> <p>GE believes the concept of sources of variability should be expanded to include multiple machines (not just multiple facilities), geometric and surface variability associated with the design of the part being fabricated, and the actual part operating environment.</p>	<p>Modify the last sentence in the first paragraph to read as follows:</p> <p>“The statistical basis of the design values must account for all sources of material variability, process variability (including multiple machines and/or facilities), final part geometric and surface variability, and the variability in the operating environment in which the final part will operate.”</p>	Suggestion	No	Partially accepted	See response to comment # 27.
35	GE Aviation	3. Third Paragraph	4	<p>Change classification processes are well defined in Part 21 such that additional amplification in this CM is unneeded.</p>	Delete this paragraph.	Suggestion	No	Not accepted	The CM provides guidance for AM processes across all relevant CS codes and Part 21, including additional guidance with respect to the classification of changes.
36	GE Aviation	3. Third Paragraph	4	<p>In addition to emerging AM processes that are the focus of this CM, some well-established repair processes can also be considered as AM. For example, the height of engine run turbine blades is traditionally restored during repair by repetitive welding passes applied to the tip of the blade to replace worn and cracked material that results from operation in the severe engine environment. This repair approach – though AM in the sense that material is added layer by layer – has typically not been classified as Major.</p>	<p>Include language here that excludes traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	Observation	No	Accepted	See comment # 16.
37	Safran Landing Systems	§1.1	3	<p><i>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.”</i></p> <p>Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.</p>	<p><u>Like cast materials</u>, AM material mechanical properties are substantially obtained during the fabrication <u>and post-fabrication operations</u> process.</p>		Objection	Partially Accepted	See response to comment # 2.
38	Safran Landing Systems	§1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the involved production organization, not limited to internal facilities, using the design specification. The statistical basis of the design values must account for all sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	<p>The applicant should, where relevant, show that AM design values they derive based on data collected from their test program is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design specification.</u></p>	Yes	No	Accepted	See response to comment # 12.

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39	Safran Landing Systems	§1.1	3	<p><i>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</i></p> <p>Comments :</p> <p>a. We fully agree with the need to use test, this will be clarified by defining the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>b. In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p> <p>c. With regard to the test specimen, we consider that instead of using a complete part as specimens, it should be less complex and more effective to obtain these values by checking of the process parameters for specific technical features. These technical features would be related, as example, to the geometry, the load applied and relevant strength, the availability of key characteristics, etc.</p> <p>This will permit to define a set of values for these specific “technical features” that will subsequently be used independently from the kind of part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens <u>or on dedicated technical features, e.g. geometry, load applied and relevant strength, key characteristics, accurately represent the final, mature production process applied to real parts through design specification and production validation.</u>	Yes	Yes	Partially accepted	See response to comment # 12 and # 13.
40	Safran Landing Systems	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limiting the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	See response to comment # 14.

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41	Safran Landing Systems	§2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</i></p> <p>Comment : Why considering AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are <u>more</u> process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 2 and # 15.
42	Safran Landing Systems	§3	4	<p><i>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)”.</i></p> <p>Comment : We agree with the principle of the control and monitoring of the design values variability, applicable to the key parameters as identified in the design specifications.</p>	The statistical basis of the design values must account for key sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)	No	Yes	Accepted	See response to comment # 12.
43	Safran Landing Systems	§3	4	<p><i>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</i></p> <p>Comment : As for any material, the Part 21.A.91 and its AMC must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<u>When</u> the use of AM in repair and repair design <u>are</u> classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.	No	Yes	Partially accepted	See response to comment # 3 and # 16.
44	Safran Landing Systems	§3	4	<p><i>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</i></p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u> .	No	Yes	Noted	See response to comment # 4.

Comment				Comment summary	Suggested resolution	Comment is an observation (suggestion)	Comment is substantive (objection)	EASA comment disposition	EASA response
NR	Author	Section, table, figure	Page						
45	Safran Landing Systems	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process, which includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place, to ensure that the POA will be aware of a CM applicable to a part he is manufacturing, in order to advise its respective competent authorities.</p>	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p>	No	Yes	Not accepted	See response to comment # 18
46	Airbus	General		<p>The CM incorporates several times the word “must” in the text. As this is a Certification Memo, the wording “must” should not be used, but rather the word “should”</p> <p>Examples:</p> <p>Section 1.1: “As such, the data used to design AM parts must account for not only.....”</p> <p>Section 3: “The statistical basis of the design values must account for all”</p>	Replace the word “must” into “should”.	Yes	No	Partially accepted	.The use of the word “must” is dependent on the context and it can be used where adherence to a specific means of compliance to a regulation is being described. In this case the text has been modified where appropriate.
47	Airbus	Section 1.1	Page 3	<p>Part of the 3rd paragraph of section 1.1 should be moved to the policy section 3 as it contains clear instructions for the applicant:</p> <p>“...The applicant should, where relevant, show that AM design values.....mature production process applied to real parts”</p>	<p>Move following part of the 3rd paragraph of section 1.1 to the policy section 3 :</p> <p>“...The applicant should, where relevant, show that AM design values.....mature production process applied to real parts”</p>	Yes	No	Partially accepted	Section 1.1 has been amended to remove specific instructions that are detailed within policy section 3.
48	Airbus	Section 1.1	Page 3	<p>In the sentence “The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</p> <p>This gives the impression that variability would be due to multiple fabrication facilities. This might not be the actual situation in practice, it would be better to use the word “considering” instead of “due to”.</p>	<p>Change text into:</p> <p>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of potential variation due to considering multiple fabrication facilities producing parts.”</p>	Yes	No	Noted	See response to comment # 13.

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NR	Author	Section, table, figure	Page						
49	Airbus	Section 1.1	Page 3	Does EASA consider the scope of this memo being both 'structure', 'cabin', and 'system'? If this memo is applicable to 'systems', does EASA consider that a specific system oriented review be done?	Please clarify in the memo the scope in terms of domains covered or excluded and that the memo is generic or specific in its application.	Yes	No	Noted	The purpose of this Certification Memorandum is to provide additional guidance regarding the usage of Additive Manufacturing (AM) technologies in Products (Aircraft, Rotorcraft and Propulsion) and Parts and Appliances subject to EASA Type Certification. Product systems are therefore considered relevant within the scope of the CM.
50	Airbus	Section 1.1	Page 3	It could be understood that AM material referred to in the Certification Memorandum is the 'raw' material (e.g. powder or wire). However CS 25.603 refers also to 'Materials' but is understood as the final material of the manufactured part. As the properties are dependent of the part manufacturing, EASA could clarify the objective of CS25.603 in the context of this CM. For instance 1st paragraph: "The applicant should demonstrate by test or experience, that the material is suitable for the intended use of the part being fabricated and that the material is being purchased per an approved material specification." It is understood that the first material is referring to fabricated material and the second to the raw material.	Please clarify and improve the wording.	Yes	No	Partially accepted	This area of the CM has revised and clarified.
51	Airbus	Section 2	Page 4	"...AM variability is controlled through material specifications in combination with process controls defined in process specifications." Every production process (Forging, Welding, Milling, Casting, Composites, etc.) needs to be specified in process and material specifications.	Change text into:....AM variability is controlled through material specifications in combination with process controls defined in process specifications, like for any other fabrication process requiring close control.	Yes	No	Partially accepted	This area of the CM has revised and clarified.
52	Airbus	Section 2	Page 4	Airbus believes that EASA might mean "electron beam" instead of "electronic beam". Also to be complete, plasma and electrical arc should be added to cover all sources.	Change text into: "...and fused using lasers, plasma, electrical arc, or electronic electron beams into near the final shape"	Yes	No	Accepted	Refer to revised CM.
53	Airbus	Section 2	Page 4	The sentence "As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts" is an assumption from the EASA at the moment. Forging, casting, composites structures are also very process dependent.	Change text into: As such, AM materials are more process dependent. than their typical metallic or non-metallic counterparts	No	Yes	Partially accepted	See response to comment # 2.

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54	Airbus	Section 3	Page 4	<p>“The use of AM in repair and repair design would normally be classified Major,”</p> <p>The use of AM in primary structure elements as referred to in GM21A.91 is not the only application for AM technology. Applications are also intended for non-critical plastic parts like endcaps, covers, air duct grid etc. in the cabin and cargo area or other metallic parts in the aircraft. These parts have no or very limited airworthiness effect. For those parts Minor classification shall be possible. Analysing the impact on airworthiness per 21A.91 and 21A.435 should be the main criterion for classification.</p> <p>Airbus does not see any reason to declare all repairs as major if the processes, specifications and materials are fully qualified.</p> <p>Also, changes or repairs to a part already manufactured using AM will be done, and classifications will need to be made. Does the existing sentence in the CM applies only for the initial certification of a part/repair using ALM or does it also apply to parts already ALM manufactured and modified?</p> <p>Therefore, it is proposed to add a reference to 21A.91 and 21A.435 and remove the above referenced part of the sentence.</p> <p>Airbus understands the word repair in the context of this CM to mean a repair part or a local addition of material.</p> <p>See also comment No 12.</p>	<p>Add a sentence before the beginning of the paragraph that starts with “In accordance with the Guidance Material...” as follows:</p> <p>Part 21A.91 and 21A.435 plus GM21A.91 and GM21A.435(a) should be used for classifying changes and repairs related to AM technology.</p> <p>Change text into:</p> <p>The use of AM in repair and repair design would normally be classified Major, Applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval.</p>	No	Yes	Partially accepted	See response to comment # 3.
55	Airbus	Section 3	Page 4	<p>EASA refer to statistically significant testing to derive the design values. This is not required by CS25.613 that refers to enough testing to establish design values on a statistical basis.</p> <p>Airbus suggest to bring the sentence in line with the CS25.613 text accordingly</p>	<p>Change text into:</p> <p>“Strength and design values used in analysis to show compliance to the certification specifications should be derived on a statistical basis through statistical significant enough testing of materials both procured and processed per approved documented specifications.”</p>	No	Yes	Partially accepted	Text revised; data should reflect the level of statistical credibility as required by the applicable CS code.
56	Airbus	Section 3	Page 4	<p>EASA refer to the statistical basis to take into account all sources of the material and process variability. It is the wording “all sources” that is ambiguous and might lead to endless discussion regarding infinite number of sources of variability. The variability is limited by the Key Process Parameters that are defined upfront.</p> <p>Therefore, Airbus propose to remove the wording “all sources”</p>	<p>Change text into:</p> <p>“The statistical basis of the design values should account for all sources of the material and process variability, including.....”</p>	No	Yes	Accepted	Refer to revised CM.

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57	Airbus	Section 3	Page 4	The sentence "...applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval" is understandable when AM is introduced for the first time on repairs to agree the way of working with the Agency, but should not be interpreted such that the privilege to classify and approve repairs will not be exercised anymore.	Change text into: "...applicants are advised to consult the Agency when introducing for the first time AM in repairs including cases where they hold a privilege for repair design approval "	Yes	No	Partially accepted	See revised CM.
58	Airbus	Appendix 1	Page 6	List of requirements are highly structure related, nevertheless many AM applications are foreseen in cabin & cargo and systems or equipment, both for plastics and metallic. Airbus notes that 25.619 is not mentioned in the list. Airbus agrees. The list serves as example only; they could be adjusted depending on the particular case in discussion between the applicant and EASA. The sentence "The subsequently listed requirements will have to be considered..." therefore should be clarified accordingly. See also comment nr.14.	Change text into: "The subsequently listed requirements will have to be considered introducing additive manufacturing technology in aviation. Note that this list could be complemented by requirements specific for the application, like for example specific structure, cabin, or system requirements."	No	Yes	Accepted	The CM has been revised to address this issue.
59	Airbus	Appendix 1	Page 6	Reference to CSX.571 might be misunderstood as not for all parts CSX.571 is applicable. Literal application of the CM would lead to making this requirement applicable for introduction of AM on all parts. Airbus proposes to remove this reference, as many other possible applicable certification requirements are not specifically mentioned neither. For instance relevant cabin & cargo requirement could be CS25.853 compartment interiors. Also potentially an equipment/ system requirement could be considered for example CS25.1301. See also comment No 13.	Please remove: CSX.571 Fatigue and Damage Tolerance	No	Yes	Not accepted	In response to comment 58, revisions have been made to the CM that eliminate the observation made by the commenter.
60	Airbus Defence and Space (ADS)	General		The words "must" and "will have to" is used several times along the Certification Memorandum. Considering the purpose of a Certification Memorandum "should" seems a more adequate terminology"	Replace the words "must"/"will have to" by "should".	Yes	No	Partially accepted	See response to comment # 46.

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61	Airbus Defence and Space (ADS)	Section 1.1	3	Regarding the sentence “ <i>The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.</i> ”, ADS consider that as currently expressed it could be understood as if variability could be due (and only due to) multiple fabrication facilities. Moreover, design values may be obtained by qualified supplier or external laboratory in accordance with a test program provided by the applicant.	Amend the sentence as proposed: “The applicant should show, where relevant, that AM design values derived are based on data collected from a test program taking into account the various degrees of variation including the multiple fabrication facilities producing parts.”	Yes	No	Accepted	See response to comment # 13.
62	Airbus Defence and Space (ADS)	Section 2	4	Typo found in this paragraph. EASA refer to “electronic beam” instead of “electron beam. Besides other source could be added as plasma and electrical arc.	Amend the sentence as proposed: “...and fused using lasers, electron beams, plasma or electrical arc into near the final shape”	Yes	No	Accepted	See response to comment # 52.
63	Airbus Defence and Space (ADS)	Section 2	4	ADS has an observation about the sentence “ <i>As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts</i> ”. That statement may not be a factual one considering current state of the art. Other manufacturing techniques like forging, casting, composites structures are also very process dependent.	ADS propose two different options: 1.-Remove the sentence 2.-Amend the text as follows: As such, AM materials are process dependent.	No	Yes	Partially accepted	See response to comment # 2.
64	Airbus Defence and Space (ADS)	Section 3	4	The sentence “ <i>Strength and design values used in analysis to show compliance to the certification specifications should be derived through statistically significant testing of materials both procured and processed per approved documented specifications</i> ” could be understood as a misalignment from CS25.613 when dealing with AM, as EASA refer to statistically significant testing to derive the design values and this is something not requested by CS25.613, which request enough testing to establish design values on a statistical basis. ADS propose an amendment in line with CS25.613	Amend the sentence as proposed: “Strength and design values used in analysis to show compliance to the certification specifications should be derived on a statistical basis through enough testing of materials both procured and processed per approved documented specifications.”	No	Yes	Partially accepted	See response to comment # 55. Note, EASA agrees that raw materials should be adequately controlled, as per the CM, however it is the final engineering properties that should satisfy the certification specifications.
65	Airbus Defence and Space (ADS)	Section 3	4	The sentence “ <i>The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)</i> ” might lead to long debate to interpret correctly the meaning behind “all sources”. The variability is limited by the Key Process Parameters. Therefore, ADS proposal is to remove the wording “all sources”	Amend the sentence as proposed: “The statistical basis of the design values should account for the material and process variability, including.....”	No	Yes	Accepted	See response to comment # 56.

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66	Airbus Defence and Space (ADS)	Section 3	4	ADS may understand the sentence “...applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval” when AM is used for the first time on repairs to enable an agreed way of working in conjunction with EASA. However it could be misinterpreted as if applicants cannot exercise their privilege for classifying and approving repairs when AM is applied.	Amend the sentence as proposed: “...applicants are advised to consult the Agency when introducing for the first time AM in repairs including cases where they hold a privilege for repair design approval”	No	Yes	Partially accepted	See response to comment # 57.
67	Airbus Defence and Space (ADS)	Section 3	Page 4	ADS does not share the sentence “The use of AM in repair and repair design would normally be classified Major,”. The use of AM for a repair does not imply a classification as Major by default. Classification should be done taking into account the impact on airworthiness as per 21A.91 (for changes to type design) and 21A.435(for repairs) and the corresponding GM. For parts that have no or very limited airworthiness effect a minor classification shall be possible.	2 comments are proposed simultaneously as resolution: 1.-Add a sentence at the beginning of the paragraph (before “In accordance with the Guidance Material...”) as follows: Changes and repairs related to AM technology should be classified following Part 21A.91 and 21A.435 plus GM21A.91 and GM21A.435(a). 2.- Remove the sentence: “The use of AM in repair and repair design would normally be classified Major”	No	Yes	Partially accepted	See response to comment # 3.
68	Airbus Defence and Space (ADS)	Appendix 1		ADS propose the deletion of paragraph CSX.571 as it could be understood as a mandatory regulation paragraph when AM is applied. Moreover, many other potentially impacted certification requirements, that may be applicable depending on the application, are not specifically mentioned (CS25.305 and CS25.307 for structural parts;CS25.853 for cargo applications; CS25.1301 for equipment...).	2 comments are proposed simultaneously as resolution: 1.-Amend the introduction wording of Appendix 1 as follows: “The subsequently listed requirements should need to be considered when introducing additive manufacturing technology in aviation. Particular requirement may need to be added depending on the specific application.” 2.-Remove reference to CSX.571 Fatigue and Damage Tolerance	No	Yes	Accepted	See response to comment # 59.
69	Safran Transmission Systems	§1.1	3	“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.” Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.	Like cast materials, AM material mechanical properties are substantially obtained during the fabrication and post-fabrication operations process	No	Yes	Partially accepted	See response to comment # 2.

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70	Safran Transmission Systems	§1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the involved production organization, not limited to internal facilities, using the design specification. The statistical basis of the design values must account for key sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	The applicant should, where relevant, show that AM design values they derive based on data collected from their tests program is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design specification.</u>	Yes	No	Accepted	See response to comment # 12.
71	Safran Transmission Systems	§1.1	3	<p><i>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation (including specimen testing).</u>	Yes	No	Accepted	See response to comment # 12.
72	Safran Transmission Systems	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limiting the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	See response to comment # 14.

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73	Safran Transmission Systems	§2	4	<p>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</p> <p>Comment : Why considering AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are <u>more</u> process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 2 and 15.
74	Safran Transmission Systems	§3	4	<p>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)”.</p> <p>Comment : We agree with the principle of the control and monitoring of the design values variability, applicable to the key parameters as identified in the design specifications.</p>	The statistical basis of the design values must account for key sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)	No	Yes	Accepted	See response to comment # 12.
75	Safran Transmission Systems	§3	4	<p>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</p> <p>Comment : As for any material, the Part 21.A.91 and its AMC must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<u>When</u> the use of AM in repair and repair design <u>are</u> classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.	No	Yes	Partially accepted	See response to comment # 3 and # 16.
76	Safran Transmission Systems	§3	4	<p>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u> .	No	Yes	Noted	See response to comment # 4 and # 17.

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77	Safran Transmission Systems	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process that includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place to ensure that the POA will be aware of a CM applicable to a part he is manufacturing, in order to advise its respective competent authorities.</p>	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p>	No	Yes	Not accepted	See response to comment # 18.
78	Safran Helicopter Engines	§1.1	3	<p><i>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.”</i></p> <p>Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.</p>	<p>Like cast materials, AM material mechanical properties are substantially obtained during the fabrication and post-fabrication operations process.</p>	No	Yes	Partially accepted	See response to comment # 2.
79	Safran Helicopter Engines	§1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the involved production organization, not limited to internal facilities, using the design specification. The statistical basis of the design values must account for key sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	<p>The applicant should, where relevant, show that AM design values they derive based on data collected from their tests program is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts and machine to machine variation within a facility through design specification.</p>	Yes	No	Accepted	See response to comment # 12.

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80	Safran Helicopter Engines	§1.1	3	<p><i>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation (including specimen testing)</u> .	Yes	No	Accepted	See response to comment # 13.
81	Safran Helicopter Engines	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limit the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D)</u> .	Yes	No	Accepted	See response to comment # 14.
82	Safran Helicopter Engines	§2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</i></p> <p>Comment : Why consider AM material more process dependent? We consider that the forging and casting material characteristics are also process dependent. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are more process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 15 and # 2.
83	Safran Helicopter Engines	§3	4	<p><i>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)”.</i></p> <p>Comment : We agree with the principle of the control and monitoring of the design values variability, applicable to the key parameters as identified in the design specifications.</p>	The statistical basis of the design values must account for key sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)	No	Yes	Accepted	See response to comment # 12.

Comment				Comment summary	Suggested resolution	Comment is an observation (suggestion)	Comment is substantive (objection)	EASA comment disposition	EASA response
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84	Safran Helicopter Engines	§3	4	<p><i>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</i></p> <p>Comment : As for any material, the Part 21.A.91 and its GM must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as Major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as Major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<p>The use of AM in repair and repair design <u>should</u> be classified Major <u>when</u></p> <p><u>When</u> the use of AM in repair and repair design <u>is</u> classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.</p>	No	Yes	Partially accepted	See response to comment # 16 and # 3.
85	Safran Helicopter Engines	§3	4	<p><i>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</i></p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	<p>Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u>.</p>	No	Yes	Noted	See response to comment # 17 and # 4.
86	Safran Helicopter Engines	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process that includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place to ensure that the POA holder will be aware of a CM applicable to a part he is manufacturing, in order to advise his respective competent authorities.</p>	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p>	No	Yes	Not accepted	See response to comment # 18.
87	Zodiac Aerospace	Front page	1	We agree with the scope.				Noted	

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88	Zodiac Aerospace	Purpose and scope	3	<p>“The applicant should, where relevant,...producing part”</p> <p>The set of test to obtain “design values” may be adapted to the criticality of the parts.</p> <p>Variability is not necessarily due to multiple fabrication facilities.</p>	The applicant should, in accordance with the criticality of the part, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of potential variation considering multiple fabrication facilities producing parts.	Yes	No	Accepted	The policy section of the CM has been revised.
89	Zodiac Aerospace	Purpose and scope	3	<p>“The applicant also should show that values obtained from tests conducted on simple specimens...real parts”</p> <p>The methodology shall be adapted to parts criticality. For low criticality parts, we shall consider that values could be applied to family of parts.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real part or a family of parts	Yes	No	Partially accepted	The policy section of the CM has been revised.
90	Zodiac Aerospace	Background	4	<p>“For metallic materials, typically,...final shape”</p> <p>What about non-metallic (ie. organic) materials?</p>	For metallic and/or organic materials, typically the as-purchased material is deposited in the machine by various methods (...)	Yes	No	Noted	No change has been made.
91	Zodiac Aerospace	Background	4	<p>“For non-metallic...final part”</p> <p>What about SLS technology on PA, for instance?</p>	Cancel this sentence and replace it by the above one.	Yes	No	Not accepted	See comment #90, EASA considers the generic text addressing metallic and non-metallic materials to provide an adequate level of detail for this CM.
92	Zodiac Aerospace	Background	4	<p>“As such, AM materials....or non-metallic counter parts”.</p> <p>We do not have significant technical data to justify that AM materials are more process dependant than other “historical” processes</p>	As such, AM is process dependant.	Yes	Yes	Partially accepted	See response to comment # 2.
93	Zodiac Aerospace	EASA Certification policy	4	<p>“The applicant should demonstrate by test or experience, that the material....material specification”.</p> <p>“Material” shall be defined with more details: powder or material after printing?</p>		Yes	No	Noted	Refer to comment # 33 for revisions made to CM.
94	Zodiac Aerospace	EASA Certification policy	4	<p>“Strength and design values used in analysis.....approved documented specifications”</p> <p>“Statistically significant” shall be detailed or eventually removed if already detailed in other standards.</p>		Yes	No	Partially accepted	See changes made regarding statistical significance , comment # 55.
95	Zodiac Aerospace	EASA Certification policy	4	<p>“The statistical basis of the design values must account for all sources of the material and process variability....multiple facilities”.</p> <p>For a pragmatic approach, we might consider the Key process parameters as source of variability.</p>	Remove “all sources of the”	Yes	No	Noted	See response to comment # 56.
96	Zodiac Aerospace	EASA Certification policy	4	<p>“Design Organisation Approval Holders...implementation of AM”. How does EASA consider the specific situation of ETSO parts?</p>		Yes	No	Noted	This CM is relevant to ETSO applications. ADOA applicants do not hold privileges related to design changes or repairs and should consult the agency during the development of the certification programme.

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97	Zodiac Aerospace	Appendix 1	6	Should be added in the list of requirements: "Part 21 sub-part G" and "Part 145"		Yes	No	Accepted	The CM has been revised to include the reference to AMC 145.A.42(c).
98	Safran Aircraft Engines Dominique Bouvier	§1.1	3	<i>"The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process."</i> Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.	<u>Like cast materials</u> , AM material mechanical properties are substantially obtained during the fabrication <u>and post-fabrication operations</u> process.	No	Yes	Partially accepted	See response to comment # 2.
99	Safran Aircraft Engines Dominique Bouvier	§1.1	3	<i>"The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts."</i> Comment : We fully agree with this position, and would clarify the means to implement this requirement to the involved production organization, not limited to internal facilities, using the design specification. The statistical basis of the design values must account for key sources of variability (material, process, final part geometric and surface..). In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.	The applicant should, where relevant, show that AM design values they derive based on data collected from their tests program is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design specification.</u>	Yes	No	Accepted	See response to comment # 12.
100	Safran Aircraft Engines Dominique Bouvier	§1.1	3	<i>"The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts"</i> . Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation. In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation (including specimen testing).</u>	Yes	No	Accepted	See response to comment # 13.

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101	Safran Aircraft Engines Dominique Bouvier	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limiting the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	See response to comment # 14.
102	Safran Aircraft Engines Dominique Bouvier	§2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</i></p> <p>Comment : Why considering AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are more process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 2 and # 15.
103	Safran Aircraft Engines Dominique Bouvier	§3	4	<p><i>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)”.</i></p> <p>Comment : We agree with the principle of the control and monitoring of the design values variability, applicable to the key parameters as identified in the design specifications.</p>	The statistical basis of the design values must account for key sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)	No	Yes	Accepted	See response to comment # 12.
104	Safran Aircraft Engines Dominique Bouvier	§3	4	<p><i>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</i></p> <p>Comment : As for any material, the Part 21.A.91 and its AMC must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<u>When</u> the use of AM in repair and repair design are classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.	No	Yes	Partially accepted	See response to comment # 16.

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105	Safran Aircraft Engines Dominique Bouvier	§3	4	<p>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u> .	No	Yes	Noted	See response to comment # 17 and # 4.
106	Safran Aircraft Engines Dominique Bouvier	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process that includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place to ensure that the POA will be aware of a CM applicable to a part he is manufacturing, in order to advise its respective competent authorities.</p>	Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.	No	Yes	Not accepted	See response to comment # 18.
107	Safran Nacelles	§1.1	3	<p>“AM is a term used to cover a range of emerging manufacturing processes (also known as 3D printing) that involve sequential-layer material addition throughout a 3D work envelope under automated control.”</p> <p>Comment : definition of AM should be precised, to exclude traditional and fully validated repetitive weld build-up repair processes, as such as powder projection process as HVOF or cold spray for example from the object of this CM.</p>	AM is a term used to cover a range of emerging manufacturing processes (also known as 3D printing) that involve sequential-layer material addition throughout a 3D work envelope under automated control. <u>Weld build-up repair processes, powder projection validated process as HVOF or cold spray for example are not considered as AM</u>	No	Yes	Partially accepted	See comment # 16.
108	Safran Nacelles	§1.1	3	<p>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.”</p> <p>Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.</p>	Like cast materials, AM material mechanical properties are substantially obtained during the <u>full</u> fabrication process.	No	Yes	Partially accepted	See response to comment # 2.

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109	Safran Nacelles	§1.1	3	<p>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification. The statistical basis of the design values must account for all sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design and special process specification.</u>	Yes	No	Accepted	See response to comment # 27.
110	Safran Nacelles	§1.1	3	<p>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation.</u>	Yes	No	Accepted	See response to comment # 13.
111	Safran Nacelles	§1.2 Table	3	<p>“Part 21, Subpart M / Repairs”</p> <p>Comment : Why limiting the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	See response to comment # 14.

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112	Safran Nacelles	§2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</i></p> <p>Comment : Why considering AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	<p>As such, AM materials are more process dependent like their typical metallic or non-metallic counterparts <u>like their typical metallic or non-metallic counterparts casting materials for example</u></p>	No	Yes	Partially accepted	See response to comment #15 and # 2.
113	Safran Nacelles	§3	4	<p><i>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</i></p> <p>Comment : As for any material, the Part 21.A.91 and its AMC must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as major.</p>	<p>The use of AM in repair and repair design <u>(or changes to Type Design)</u> would normally be classified Major <u>for critical structures</u>. Applicants are advised to consult the Agency when introducing AM in repairs <u>classified Major</u>, including cases where they hold a privilege for repair design approval</p> <p><u>Critical Structure: A load bearing structure/element whose integrity is essential in maintaining the overall flight safety of the aircraft. This definition was adopted because there are differences in the definitions of primary structure, secondary structure, and principle structural elements (PSE) when considering the different categories of aircraft. For example, PSE are critical structures for Large Aeroplanes.</u></p>	No	Yes	Partially accepted	See response to comment # 3 regarding classification of changes and repairs. Note regarding comment concerning critical structures, this CM does not alter definitions in existing CSs and guidance material.
114	Safran SA	§1.1	3	<p><i>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.”</i></p> <p>Comment : Why consider the mechanical properties as unique to AM material? For other types of materials also, the final mechanical properties are substantially obtained during the fabrication process.</p>	<p><u>Like cast materials</u>, AM material mechanical properties are substantially obtained during the fabrication <u>and post-fabrication operations</u> process.</p>	No	Yes	Partially accepted	See response to comment # 2.
115	Safran SA	§1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the involved production organization, not limited to internal facilities, using the design specification. The statistical basis of the design values must account for key sources of variability (material, process, final part geometric and surface..).</p> <p>In addition to multiple facilities, multiple machines within a given facility can also be a source of variation.</p>	<p>The applicant should, where relevant, show that AM design values they derive based on data collected from their tests program is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts <u>and machine to machine variation within a facility through design specification.</u></p>	Yes	No	Accepted	See response to comment # 12.

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116	Safran SA	§1.1	3	<p><i>“The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts”.</i></p> <p>Comment : We fully agree with this position, and would clarify the means to implement this requirement to the production organization, using the design specification and production validation.</p> <p>In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	The applicant also should show that values obtained from tests conducted on simple specimens accurately represent the final, mature production process applied to real parts <u>through design specification and production validation (including specimen testing).</u>	Yes	No	Accepted	See response to comment # 13.
117	Safran SA	§1.2 Table	3	<p><i>“Part 21, Subpart M / Repairs”</i></p> <p>Comment : Why limiting the scope of the CM to the Repair (Part 21, subpart M)? It should be also applicable to new designs. We recommend adding references to Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</p>	To add references in the table : <u>Certification (Part 21, subpart B) and Changes to Type-Certificates (Part 21, subpart D).</u>	Yes	No	Accepted	See response to comment # 14.
118	Safran SA	§2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts”.</i></p> <p>Comment : Why considering AM material more process dependent? We consider that the forging and casting material characteristics are also process dependant. AM process is a relatively new process, which will need special attention in the preliminary implementation phase for each manufacturer.</p>	As such, AM materials are more process dependent like their typical metallic or non-metallic counterparts casting materials for example	No	Yes	Partially accepted	See response to comment # 15.
119	Safran SA	§3	4	<p><i>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)”.</i></p> <p>Comment : We agree with the principle of the control and monitoring of the design values variability, applicable to the key parameters as identified in the design specifications.</p>	The statistical basis of the design values must account for key sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable)	No	Yes	Accepted	See response to comment # 12.

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120	Safran SA	§3	4	<p><i>“The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval”.</i></p> <p>Comment : As for any material, the Part 21.A.91 and its AMC must be applied to the part using Additive Manufacturing process. However, not all repairs using A. M. should be classified as major, and DOA privileges should apply when the material is known. This should also apply to Changes to Type Design.</p> <p>This CM should define the specific criteria for classifying the parts using AM as major.</p> <p>This CM should ensure to exclude traditional repetitive weld build-up repair processes from the requirement to be classified as Major.</p>	<p><u>When</u> the use of AM in repair and repair design <u>are</u> classified Major, applicants are advised to consult the Agency <u>even if</u> they hold a privilege for repair design approval.</p>	No	Yes	Partially accepted	See response to comment # 16.
121	Safran SA	§3	4	<p><i>“Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM”.</i></p> <p>Comment : As DOH / TCH, we use to involve the Agency in our research project when developed in the frame of future short term application. However, not being in a certification process phase, such research projects are shared only when they are enough mature and representative.</p>	<p>Design Organisation Approval Holders are <u>recommended</u> to involve the Agency <u>when AM implementation is decided</u>.</p>	No	Yes	Noted	See response to comment # 4.
122	Safran SA	§3	5	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p> <p>Comment : CM is applicable to the TCH through the certification basis (CRI). The TCH will define in the Type Design definition, all the design specifications, including material, manufacturing and control specifications. In addition, the manufacturing process will be qualified through the production validation process (detailed manufacturing process that includes Type Design specifications and Production facilities specifications). Therefore, the way the POA(s) will work with its (their) POA(s) Surveillance Authority (usually the local NAA) is not under the control of the TC holder.</p> <p>CM should suppress this paragraph or describe the process in place to ensure that the POA will be aware of a CM applicable to a part he is manufacturing, in order to advise its respective competent authorities.</p>	<p>Production Organisation Approval holders are advised to ... and/or continued surveillance of the POA.</p>	No	Yes	Not accepted	See response to comment # 18.

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123	Airbus Helicopters		all	<p>General comment:</p> <p>This proposed CM does not take into account the safety classification of components and basically the requirements introduced in this CM are too much restrictive. Consequently this CM as is will impair the potential benefits of this technology.</p> <p>Proportionality should be introduced in order to consider differently parts based on their safety classification.</p>	<p>See individual comments below for proposals.</p> <p>More generally, an introductory sentence would be appreciated.</p>		Yes	Not accepted	<p>The CM is intended to provide guidance on a particular subject and, as non-binding material, may provide complementary information and guidance for compliance demonstration with current standards. Certification Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM). Certification Memoranda are not intended to introduce new certification requirements or to modify existing certification requirements and do not constitute any legal obligation.</p> <p>Part criticality is considered by EASA during certification and is reflected in the published CM. It is therefore not considered that the CM impairs the introduction of Additive Manufacturing within the aerospace sector.</p>
124	Airbus Helicopters	§ 1.1	3	<p><i>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process.”</i></p> <p>Final properties are obtained after AM post treatment if any (heat treatment, surface finishing ...)</p>	<p><i>“The unique feature of AM materials is that their final mechanical properties are obtained during the fabrication process and its post treatment”</i></p>	Yes		Partially accepted	See response to comment # 13.
125	Airbus Helicopters	§ 1.1	3	<p><i>“The applicant should, where relevant, show that AM design values they derive based on data collected from their internal facilities is also relevant for the various degrees of variation due to multiple fabrication facilities producing parts.”</i></p> <p>This sentence raises the following comments:</p> <ul style="list-style-type: none"> - The concept of design values is not systematically applied: this depends on parts criticality; <i>“where relevant”</i> does not explicitly reflect this, - Design value are not in all cases obtained with internal facilities; they may be obtained through a "privileged" supplier or external laboratory following a test program written by the applicant and including process robustness to validate a process window, - Variability may come from other factors than multiple manufacturing sites. 	<p>Consequently, we suggest an amended sentence like:</p> <p><i>“The applicant should, where relevant in accordance with the criticality of the part, show that AM design values they derive based on data collected from their internal facilities tests program is also relevant for the various degrees of variation due to, considering multiple fabrication facilities producing parts”</i></p>		Yes	Partially accepted	See revised CM.
126	Airbus Helicopters	§ 2	4	<p><i>“For metallic materials, typically the as-purchased material is deposited in the machine by various methods and fused using lasers or electronic beams into near the final shape. Non-metallic materials may be heated and extruded through a moving nozzle to create a final part.”</i></p> <p>The listed technologies are not the only possible ones. Arc plasma wire feed is an example of another technology and laser for organic as well.</p>	<p>Consequently, we suggest amending these sentences in one sentence like:</p> <p><i>“For metallic and organic materials, typically the as-purchased material is deposited in the machine by various methods and fused using lasers or electronic beams various methods into near the final shape. Non-metallic materials may be heated and extruded through a moving nozzle to create a final part.””</i></p>	Yes		Partially accepted	See response to comment # 52.

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127	Airbus Helicopters	§ 2	4	<p><i>“As such, AM materials are more process dependent than their typical metallic or non-metallic counterparts.”</i></p> <p>This statement is an assumption from EASA at the moment. Forging, casting, composites are also much process dependent.</p>	<p>We suggest simply stating: <i>“As such, AM material are process dependent”</i></p>		Yes	Accepted	See response to comment # 12.
128	Airbus Helicopters	§ 2	4	<p><i>“AM variability is controlled through material specifications in combination with process controls defined in process specifications.”</i></p> <p>First of all, process control will depend on the criticality of AM parts.</p> <p>Also, the concept of inspection plan is missing.</p>	<p>We suggest the following: <i>“AM variability is controlled through material specifications in combination with an inspection method. Process control, including an inspection plan which depends on the part’s criticality defined in process specifications.”</i></p>		Yes	Partially accepted	See revision to Section 3 of the CM.
129	Airbus Helicopters	§ 3	4	<p><i>“Independent of the facility where parts are to be fabricated, the applicant should demonstrate compliance to the relevant paragraphs of the applicable CS listed under appendix 1 of this CM.”</i></p> <p>This sentence includes 2 concepts:</p> <ul style="list-style-type: none"> - First concept is the applicability of the CS paragraphs listed in appendix 1, - Second concept is the possible variability of the process depending on the manufacturing site. 	<p>We suggest;</p> <ul style="list-style-type: none"> - Removing from this sentence the concept of possible various manufacturing sites, which is further addressed in the text, - Clarifying the concept of how to use this CM in relation with the paragraphs referenced in appendix 1, for example through the following sentence: <i>“The applicant should use this CM in relationship with the relevant paragraphs listed under appendix 1 of this CM, as applicable.”</i> <p>This proposal is also a way to clarify that the expected process control is dependent on the criticality of parts to be manufactured.</p>		Yes	Noted	See response to comment # 58.
130	Airbus Helicopters	§ 3	4	<p><i>“The applicant should demonstrate by test or experience, that the material is suitable for the intended use of the part being fabricated and that the material is being purchased per an approved material specification”</i></p> <p>Our interpretation is that “material” designates the “raw material”.</p> <p>Is this the correct interpretation?</p>	<p>Clarify if needed.</p>	Yes		Noted	The text is clarified in Section 3 of the revised CM.
131	Airbus Helicopters	§ 3	4	<p><i>“The applicant should demonstrate by test the capability of the fabrication method to produce a consistently sound structure which is performed under an approved process specification”</i></p> <p>The mention of an inspection plan is missing.</p> <p>Moreover, the sentence needs clarification.</p>	<p>We suggest the following sentence: <i>“The applicant should demonstrate by test the capability of the fabrication method to produce a consistently sound structure which is performed under an approved process specification, and controlled by approved inspection methods.”</i></p>		Yes	Partially accepted	See response to comment # 128.

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132	Airbus Helicopters	§ 3	4	<p><i>“Strength and design values used in analysis to show compliance to the certification specifications should be derived through statistically significant testing of materials both procured and processed per approved documented specifications.”</i></p> <p>The proposed text refers to “statistically significant testing” to derive the design values. This is not required by CS-X.613, which refer to enough testing to establish design values on a “statistical basis”.</p>	<p>We suggest bringing the sentence in line with CS-X.613, e.g.:</p> <p><i>“Strength and design values used in analysis to show compliance to the certification specifications should be derived through statistically significant enough testing of materials both procured and processed per approved documented specifications.”</i></p>		Yes	Partially accepted	See response to comment # 50.
133	Airbus Helicopters	§ 3	4	<p><i>“The applicant is responsible for ensuring that design values used in the evaluation of any parts produced using AM are applicable to the material and process specifications used to fabricate the parts and that the design values are applicable to the facilities at which the parts are fabricated.”</i></p> <p>Our understanding is that the applicant is responsible to ensure that the process as applied in each manufacturing site is the process which has been qualified.</p> <p>However, the sentence needs clarification.</p>	Please clarify this sentence.		Yes	Noted	This section of the CM has been revised.
134	Airbus Helicopters	§ 3	4	<p><i>“The statistical basis of the design values must account for all sources of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable).”</i></p> <p>The text refers to the statistical basis to take into account all sources of the material and process variability. The term “all sources” is ambiguous and might lead to endless discussion regarding infinite number of sources of variability. The variability is limited by the Key Process Parameters that are defined upfront.</p>	<p>We suggest the following sentence:</p> <p><i>“The statistical basis of the design values must account for all sources key parameters of the material and process variability, including that introduced by fabricating parts at multiple facilities (where applicable).”</i></p>		Yes	Accepted	See response to comment # 56.
135	Airbus Helicopters	§ 3	4	<p><i>“The applicant is requested to provide details to the Agency on how constituent materials are being purchased and on how the fabrication process is being controlled.”</i></p> <p>This should not be requested whatever the part criticality.</p>	<p>We suggest the following sentence:</p> <p><i>“Depending on the criticality of the part, the applicant is requested to provide details to the Agency on how constituent materials are being purchased and on how the fabrication process is being controlled”</i></p>		Yes	Noted	See response to comment # 5.
136	Airbus Helicopters	§ 3	4	<p><i>“For repair and repair design the guidance contained in this Certification Memoranda (relevant requirements under appendix 1 of this CM) should also be considered when evaluating the use of AM.”</i></p> <p>Is there a distinction made between “repair” and “repair design”?</p>	Clarification expected	Yes		Noted	EASA considers existing text as adequate to ensure that repair from design through to execution is appropriately addressed.

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137	Airbus Helicopters	§ 3	4	<p><i>"The use of AM in repair and repair design would normally be classified Major, applicants are advised to consult the Agency when introducing AM in repairs including cases where they hold a privilege for repair design approval."</i></p> <p>This sentence raises the following comments:</p> <ul style="list-style-type: none"> - The classification of repairs is based on 21.A.435 (which calls 21.A.91); GM 21.A.91 considers as major "(ii) changes to materials, processes or methods of manufacture of primary structural elements, such as spars, frames and critical parts;"; consequently, the use of AM in a repair should not be considered a major change, except for PSE and critical parts, - Applicants should not have to consult the Agency when they hold a privilege for major repair approval. 	<p>We suggest the following sentence:</p> <p><i>"The use of AM in repair and repair design would normally should be classified Major according to 21.A.435. Applicants are advised to consult the Agency when introducing AM in repairs including cases where, unless they hold a privilege for repair design approval."</i></p>		Yes	Partially accepted	Refer to comment # 3, # 16. The CM is intended to foster engagement with applicants when introducing AM.
138	Airbus Helicopters	§ 3	4	<p><i>"Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM."</i></p> <p>This should be based on the parts' criticality.</p>	<p>We suggest the following sentence:</p> <p><i>"Depending on the criticality of the parts to be manufactured, Design Organisation Approval Holders are advised to involve the Agency at the earliest opportunity during the development and implementation of AM."</i></p>		Yes	Not accepted	The CM is intended to foster engagement with applicants when introducing AM. Part criticality is considered by EASA during certification and is reflected in the published CM
139	Airbus Helicopters	§ 3	5	<p>Sub-section <i>"Impact of AM on production organisations."</i></p> <p>Based on GM 21.A.147(a), significant changes in the approved production organisation can be <i>"Changes in the production or quality systems that may have an important impact on the conformity/airworthiness of each product, part or appliance."</i> Consequently, a change in a production process related to a PSE or critical part is a significant change.</p> <p>This cannot be the case whatever the criticality of manufactured parts.</p>	<p>We suggest adding an introductory sentence to clarify that all those POA considerations apply in the case the AM process is introduced to be used in the manufacturing of PSE or critical parts.</p>		Yes	Not accepted	The CM is intended to foster engagement between POAs and the competent authority when introducing AM.
140	Airbus Helicopters	§ 3	5	<p><i>"In case of such a change, the competent authority is recommended to inform the EASA Certification Directorate, and, as usual, these parties are also recommended to cooperate closely."</i></p> <ul style="list-style-type: none"> - It is not clear how this CM will reach the competent authorities in charge of monitoring the POA holders, - The AM process, when justified by the criticality of parts to be manufactures, should have been agreed by EASA in the frame of the design approval, including process control dispositions. <p>Consequently, this recommendation looks useless.</p>	<p>Consequently, we suggest removing this sentence.</p>	Yes		Partially accepted	<p>The CM provides general guidance within the field of AM implementation from a certification perspective.</p> <p>Requirements are in place regarding the DOA – POA interface, furthermore EASA and NAA's will communicate the guidance found in the CM to POA holders during the course of the POA oversight.</p> <p>The revised CM recognises within the frame of the production organisation that AM should be controlled in accordance to the published design date requirement as required by Part 21.A.131.</p>

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141	Airbus Helicopters	Appendix 1	6	Identifying critical parts is a requirement, whatever the manufacturing process. Consequently, the reference to 21.A.805 looks useless.	Remove reference to 21.A.805.	Yes		Accepted	The CM has been amended accordingly.
142	Airbus Helicopters	§ 1.1 § 3	3 4	The word “ <i>must</i> ” is used, which is not in line with the nature of a CM.	Use “ <i>should</i> ” instead of “ <i>must</i> ”.	Yes		Partially accepted	See response to comment # 46.
143	Textron Aviation		3	The draft indicates that “the statistical basis of the design values must account for all sources of the material and process variability ...” In some cases it may be impossible or cost-prohibitive to perform testing to capture all sources of variability. §25.619 prescribes use of special factors when strength of structure is subject to appreciable variability due to uncertainties in manufacturing processes. We believe that the §25.621 casting factors would be appropriate for application to additive manufacturing.	Allow applicants to apply the casting factors in §25.621 in lieu of a large-scale test program to completely encompass all sources of variability.			Noted	The use of alternate approaches would need to be evaluated as part of the certification programme.
144	GAMA	General		<p>GAMA is pleased to see that EASA has issued this Certification Memorandum to provide guidance to applicants regarding the usage of additive manufacturing (AM) technologies in products, parts and appliances subject to EASA Type Certification. As EASA has indicated, the introduction of additive manufacturing presents unique but manageable challenges for the authorities and industry regarding the introduction of AM in the areas of design, production and maintenance.</p> <p>GAMA is supportive of working with the authorities to ensure the variability of additive manufacturing is controlled in such a way to minimize risk and facilitate efficient certification processes. To this end, GAMA encourages EASA to continue to collaborate with other government agencies as well as industry to identify hazards and mitigations necessary to establish the appropriate standards and methods of compliance necessary to enable safe implementation of these technologies. As part of this coordination to reduce risk and facilitate efficient certification processes, GAMA encourages EASA to recognize and reference industry standards as appropriate to satisfy an acceptable means of compliance.</p>				Noted	EASA encourages the development of appropriate standards for AM in support of product certification.

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145	GAMA	Section 1.1 Third paragraph		<p>The first sentence of this paragraph state that AM is “unique” because “the final mechanical properties are obtained during the fabrication process”. While it is true that the mechanical properties of AM parts are primarily “obtained during the fabrication process”, this concept is not unique to AM. Casting represents another range of manufacturing processes where the mechanical properties are substantially established during the fabricate process.</p> <p>Post-fabrication operations such as heat treatments (including thermal cycles associated with brazing components together), hot isostatic pressing (HIP) and application of environmental and/or wear resistant coatings to AM parts also impact final part mechanical properties.</p>	GAMA suggests EASA revise this sentence to read: “like cast materials, AM material mechanical properties are substantially obtained during the fabrication process.” Also, add a reference to the potential impact of post-fabrication operations on final mechanical properties.			Partially accepted	See response to comment # 2.
146	GAMA	1.1 Third paragraph		<p>(1) – the phrase “their internal facilities” is too restrictive as “external facilities” are also likely to be used to produce AM parts.</p> <p>(2) - In addition to multiple AM facilities, multiple AM machines within a given facility can also be a source of variation.</p> <p>(3) - In addition to the established production process parameters, actual part properties are influenced by multiple factors including part orientation during the build operation, support structure required during the build operation that is subsequently removed, surfaces that have properties different from the rest of the component and/or test specimens (e.g. internal cavities where the surface roughness may be considerably different), and potential anisotropy resulting from sequential layer-by-layer addition of material. Test specimens used to establish mechanical properties must also address these actual part conditions that can impact mechanical properties of the fabricated part.</p>	<p>(1) - GAMA recommends EASA replace the phrase “their internal facilities with “production facilities”.</p> <p>(2) - GAMA recommends EASA add a phrase “and machine to machine variation within a facility” to the end of the third sentence.</p> <p>(3) - To this end, GAMA requests EASA add more content around the topic of specimen testing use of “simple specimens”.</p>			Accepted	See response to comment # 12.
147	GAMA	Section 2 Fourth sentence		The phrase “more process dependent” can be a little misleading. As highlighted in comments to section 1.1, in addition to AM there are other fabrication processes (e.g. casting processes) where the mechanical properties are substantially established during the fabrication process. GAMA believes the emphasis of this section should focus on the importance of properly characterizing the AM material and resultant mechanical properties rather than the uniqueness of AM processes.	To this end, GAMA suggests EASA delete the fourth sentence in this paragraph.			Accepted	The CM has been revised in this context.
148	GAMA	Section 2 Fifth sentence		Section 1.1 uses the term “as-purchased material” while this sentence uses “constituent materials as purchased by the suppliers”.	GAMA recommends using a single term throughout this document.			Accepted	The CM has been revised.

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149	GAMA	Section 2 Last sentence		As highlighted in comments to section 1.1, post-fabrication processing can have an impact on design values used for AM materials.	GAMA recommends EASA add the phrase “including post processing operations” to the end of this sentence.			Accepted	See response to comment # 32.
150	GAMA	Section 3		This section makes no mention of materials of process specifications.	Therefore GAMA recommends EASA add a sentence where appropriate to highlight the fact that “applicants should provide evidence that materials and processes are addressed by specifications and the specifications are under revision control.”			Accepted	See response to comment # 33.
151	GAMA	Section 3 First paragraph		The current focus of the last sentence is establishing design values based on assessment of both material variability (assumed to be in reference to raw material) and process variability, as well as any variability associated with fabricating parts at multiple facilities. GAMA believes the concept of sources of variability should be expanded to include multiple machines (not just multiple facilities), geometric and surface variability associated with the design of the part being fabricated, and the actual part operating environment.	GAMA suggests EASA modify the last sentence in the first paragraph to read “the statistical basis of the design values should account for all sources of material variability, process variability (including multiple machines and/or facilities), final part geometric and surface variability, and the variability in the operating environment in which the final part will operate.”			Accepted	See response to comment # 27.
152	GAMA	Section 3 Third paragraph		In addition to emerging AM processes that are the focus of this CM, some well-established repair processes can also be considered as AM. For example, the height of engine run turbine blades is traditionally restored during repair by repetitive welding passes applied to the tip of the blade to replace worn and cracked material that results from operation in the severe engine environments. This repair approach – though AM in the sense that material is added layer by layer – has typically not been classified as Major.	GAMA requests that EASA include clarifying language that excludes traditional repetitive weld build-up repair processes from the requirement to be classified as Major.			Accepted	See response to comment # 16.
153	Bell Helicopter	3. Policy & Guidance	4 &5	This set of rules does not differentiate between PSE and non-PSE parts manufactured using additive manufacturing. A typical example of a non-PSE part is an environmental cooling duct that carries very little load and is not considered a PSE part.			X	Noted	The CM is intended to foster engagement with applicants when introducing AM. Part criticality will, as always, be considered during certification and is reflected in the published CM.

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154	Bell Helicopter	3. Policy & Guidance	4 &5	<p>2. Classification distinction should be made for the type/intended purpose of parts to be manufactured. These classifications would address the initial qualification of material/process combination qualification and the design and the quality control process based on the whether or not the part is, or is not, a PSE. PSE parts may require process controls including source of material, machine used, process, programming, etc. A PSE may also require a level of sampling for DT, NDI or possibly proof loading and additional qualification testing and analysis but a non-PSE secondary structure or non-structural components (such as an antenna mount or specific component in a system with designed in redundancy) will only need an analysis completed to the basic material qualification data and may only require visual inspection for defects.</p>	<p>We should propose some categories like (in decreasing levels of process qualification, design verification and manufactured part quality verification requirements):</p> <p>a. PSE - Structural element – increased sample sets, coupons/elements that would evaluate the behaviour of the materials and process. i.e. all reasonable process defect and evaluations quality controls to Powder requirements/controls, NDI requirements, fatigue life, machine control variations, machine qualifications thickness limitations, etc. (this would involve the full level of interest as described in the CM-S-008 Issue 01)</p> <p>b. Non-PSE – level of interest by certification agencies not required</p> <p>1.Secondary structure – coupon tests for variations and increased quality inspection to NDI or in process records and justification for secondary structure status (such as FMEA showing redundancy or design considerations sizing the parts other than the load as is common in fire zone structure)</p> <p>2.Non-structural – Material control Process control and a statistically meaningful test set to produce material characteristics to be gathered in report format for design data for evaluation of the parts and part quality control not to exceed a visual inspection and simple co-coupons.</p>		X	Noted	This CM represents a starting pointing for evaluation with applicants. Such considerations should form part of the certification programme.
155	Bell Helicopter	3. Policy & Guidance	4 &5	<p>Allowing a much lower threshold for qualification oversight for each of the lesser categories of a material and process qualification would allow the Certification Agencies to focus the level of interest to the qualification level where the level of safety is maintained and allow for a non-PSE low threshold for entry for Design Organization Approval Holders to build experience in areas where safety is not affected.</p>			X	Noted	See comment # 154.