EASA Proposed CM-PIFS-007 Issue 01 – Engine Critical Parts - Damage Tolerance Assessment - Manufacturing and Surface Induced Anomalies - Comment Response Document

Comment				Comment summary	Suggested resolution	Comment is an observation or is a suggestion	Comment is substantive or is an objection	EASA comment disposition	EASA response
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1	*Francis Fagegaltier*	All	All	The proposed text correctly refers to feedback from service experience to TC holders (see in particular A2 para 2 second bullet) in relation to Part 21.A.3. The Agency should consider adding a note pointing to a message which is currently "hidden" deeply in another Part 21 related document but is very important for safety of critical parts.	To add a note similar to the following : Note: any repair to a critical part must be considered as a major repair as specified in the **GM 21A.435, §3 ii.**	Yes	No	Noted	EASA agrees fully with the observation. However, the proposed CM is not intended to provide guidance for the classification of repairs. Therefore, it is not necessary to include the note suggested.
2	*GE Aviation*	---	---	GE Aviation welcomes the opportunity to review and provide comment on the subject Certification Memorandum. GE Aviation has reviewed the document and finds it to be consistent with the draft to which GE Aviation had input as a member of the AIA Rotor Integrity Sub-Committee. GE Aviation has no suggested changes.		---	---	Noted	Propulsion industry were involved in the development of the proposed CM through the AIA Rotor Integrity Sub-Committee (RISC).
3	*Tim Mouzakis* *FAA, ANE-111*	Section 1.1, third para.,second sentence	4	This statement is not compatible with CS-E 515 paragraph (a) that states, "Appropriate Damage Tolerance assessments must be performed to address the potential for failure from material, manufacturing…"	This sentence must be removed.	Yes	Yes	Accepted	EASA recognises that the subject sentence may be misconstrued and therefore, the CM is amended to delete this sentence.
4	*Tim Mouzakis* *FAA, ANE-111*	Section 3.1, para. B1	7	The proposed risk level of CS-E 510(a)(3) is less than the allowable risk required in FAA Damage Tolerance AC's.	EASA to clarify in CM that the term "individual failure" in CS-E 510 (a)(3) implies engine level risk.	Yes	Yes	Partially Accepted	The risk levels identified within the CM are compatible with those of CS-E 510 and approximately consistent with those of the relevant FAA Advisory Circulars (ACs). EASA does however, recognise that additional clarification can be provided as suggested. In order to do so a note has been added to paragraph 3.1 B1.
5	*Rolls-Royce plc*	3.1	5	"This EASA policy addresses surface damage tolerance in critical rotating parts . . ." Surely it applies to all Critical Parts?	"This EASA policy addresses surface damage tolerance in critical parts . . ."	Yes	Yes	Not Accepted	The title of the CM has been chosen in order to be consistent with the title of CS-E 515. The CM however, clearly states that the guidance provided therein is applicable to rotating Critical Parts only. No additional guidance is provided for static Critical Parts, the approved life of which may be based on the crack initiation life plus a portion of the residual crack growth life (AMC to CS-E 515 (3)(e)(i) refers).
6	*Rolls-Royce plc*	3.1	5, 6	There is considerable confusion over what the "minimum level of damage tolerance capability" is meant to represent. It is unclear why 3000 cycles or 50% of the part certified life is meaningful although the crack sizes suggested are very extreme. Can EASA please clarify why this is thought to be sufficient? Especially in operations with significantly longer shop visit inspection opportunities than 3000 cycles?	"An initial level of damage tolerance will be understood if a reaction time of 3000 cycles or 50% of the certified life is demonstrated for a crack which could just pass a typical inspection for a in piece part condition using a simple fracture mechanics approach."	Yes	Yes	Not Accepted	The assumptions used in the deterministic assessment are provided in line with the principles of the initial RISC deterministic surface fracture mechanics approach (January 2006) which was to consider simple assumptions in order to achieve a baseline damage tolerance using data available early in the design. The combination of the simple assumptions when considered together are understood to provide an acceptable level of safety.
7	*Rolls-Royce plc*	3.1	5	"a service damage monitoring process should be established". We agree. However the type certificate holder does not own the data on service damage which is the operators' responsibility. Will they be mandated to provide this data?	Clarification of operator and overhaul bases reporting responsibilities under this proposal	Yes	No	Not Accepted	Imposing requirements to operators and overhaul bases is outside the scope of the CM. This CM is addressed to Design Organisations only.
8	*Rolls-Royce plc*	3.1	5	"In addition, an alternative probabilistic compliance approach . . ."	Remove "In addition". Should read "A complementary probabilistic compliance assessment should be .. . ."	Yes	Yes	Not Accepted	The probabilistic approach is an alternative one.

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9	*Rolls-Royce plc*	3.1	5	"... To ensure that service damage is consistent with serviceable and repairable limits . . "	There is a potential disconnect here. Damage which is repairable might well not be acceptable because, say, reducing a section thickness could be allowed but leaving a sharp damage mark which cracks and grows into the part would not be. Of course this is why it's repaired and not serviceable. What is really needed is for the OEM to define a level of service damage which has flown above that which it would be necessary to review the assumptions made in establishing damage tolerance, but this need not be related to a repairable limit. Clearly if such damage is to be reported it would have to be above the serviceable limit.	Yes	Yes	Not Accepted	Using the deterministic criteria, a damage mark is treated as a crack from day one and therefore, no additional assumptions would be made related to establish the simplistic deterministic assessment. However, for the probabilistic assessments made in accordance with section 3.1 B3. the review of assumptions outlined in the comment are already addressed. It should be noted that this CM should not alter the requirements of Part 21 with respect to the reporting of unsafe or potentially unsafe conditions.
10	*Rolls-Royce plc*	3.1	5	"Where the Type Certificate Holder has demonstrated that they achieve the objectives on FAA AC 33.70-2, the applicant would not need to consider this Certification Memorandum for those features addressed by the AC"	In AC 33.70-2, credit can be gained which allows higher stressing of the hole feature by improving the manufacturing controls. Furthermore the determination of appropriate manufacturing controls depends on the area of all holes of a type (PCD). So a single highly stressed hole, in say a shaft, would not need special controls because it is small and there's only a few. However it can be subject to occasional handling damage. So how does meeting AC 33.70-2 ensure damage tolerance to service anomalies?	Yes	Yes	Not Accepted	FAA AC 33.70-2 does not necessarily take individual, specific cases of high stress concentration features into account. It is rather a whole engine probabilistic assessment and it is deemed acceptable at this time.
11	*Rolls-Royce plc*	3.1	6	Determine the serviceable and repairable surface damage limits using a process approved by the Agency and summarised within the service management plan.	OEMs should be free to set lower serviceable and repairable damage limits to force the reporting of damage at entry to service of a new design. Ideally the limits should evolve in the light of what actually arises since setting bigger limits in low stressed areas will simply allow systematic damage to be repaired unreported reducing the likelihood of its elimination. Suggest "The Applicant should demonstrate the suitability of the serviceable and repairable limits using a process approved by the Agency."	Yes	Yes	Not Accepted	The proposed change is equivalent to the corresponding wording in the CM with the only difference being that the damage limits need to be summarised within the service management plan. Serviceable and repairable limits are established during the certification programme and are agreed between the applicant and the Agency during the certification programme.
12	*Rolls-Royce plc*	3.1 A2	6	"Establish a monitoring process to record damage that meets all of the following criteria: - is consistent with or exceeds repairable limits;"	As explained above we need to define a reportable limit which is not necessarily the same as a repairable limit	Yes	Yes	Not Accepted	See EASA response to comment 9. above.
13	*Rolls-Royce plc*	3.1 B	7	"Anomaly size / frequency distribution"	Clarify that this should be appropriate for the component	Yes	Yes	Accepted	Section 3.1 B1. has been amended accordingly.
14	*Rolls-Royce plc*	3.1B	7	For alternative Probabilistic compliance clarify that Type certificate holder general experience not just for specific engine type can be considered	Wording on page 7 about use of experience	Yes	Yes	Noted	On a case by case basis EASA may consider additional experience, not just for the specific engine type being taken into account. That would be based on the relevance and appropriateness of the data. The CM is not changed as a result of the comment. This would be dealt with on an individual basis.
15	*Rolls-Royce plc*	3.1 A	6	"The serviceable and repairable limits should be published in the ICA."	Currently these are in the Engine Manual but not the ICA under the inspection instructions. These are referenced in the ICA. Why is it now necessary to place these limits in the ICA? Suggest "referenced in the ICA" so they can be updated more easily.	Yes	Yes	Not Accepted	The Engine Manual is a part of the ICA as identified in CS-E 25. In addition, any document referenced in the ICA becomes automatically an element of the ICA with respect to the referenced data and instructions.

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16	*UK CAA*		6	**Paragraph No:** A1 Deterministic Damage Tolerance estimate. **Comment:** The assessment calls for a critical part life of at least 3000 cycles or 50% of the part certified life, whichever is *less*. This is not covering the case where high time parts may be fitted for much longer periods than 3000 cycles (flights) between shop visits. **Justification**: It is suggested that the aim of this requirement should be that, for those features which are comparatively highly stressed and hence low lifed, introducing damage will not lead to failure before the retirement of the part, while for those parts which are lower stressed and hence have higher declared lives the aim should be to show that the part is likely to reach shop visit before failure. As worded, components which have high lives are only required to show a life of 3000 cycles, (which is taken to mean 3000 flights) and this is likely to be only a fraction of typical time to overhaul or shop visit.	**Proposed Text (if applicable):** Amend text to require that the surface fracture mechanics life exceeds the life prior to retirement or expected life to shop visit.			Not Accepted	See EASA response to comment 6. above.
17	*UK CAA*		6	**Paragraph No:A1 (b)** **Comment:** It is customary to quote anomaly sizes in terms of "length x depth" For the first bullet point, the anomaly is quoted as "depth x length", although the feature is described as semicircular. **Justification:** possible confusion with standard methodology for defining a defect.	**Proposed Text (if applicable):** 0.762mm x 0.381mm (0.030 inches x 0.015 inches) for an assumed (semicircular) surface anomaly			Accepted	Quotation for crack sizes in the CM will be changed accordingly.
18	*UK CAA*		6	**Paragraph No:A1** **Comment:** The paragraph does not draw attention to external effects which might have a significant influence on the result of the analysis. **Justification:** In particular**, r**elatively low levels of vibration can have a significant effect on the overall stress cycle. For some features, such as blade slots or other disc rim features, the level of vibration applied can significantly reduce the life which can be declared.	**Proposed Text (if applicable):** add sub para (e) The effects of the operating environment on the stress cycle e.g. background vibration should be taken into account			Partially Accepted	Paragraph 3.1 A1. (c) has been amended accordingly.
19	*UK CAA*		6	**Paragraph No:** A1, first sentence **Comment:** it is not clear from the text whether or not EASA expect a safety factor to be applied to the result of the damage tolerance assessment. In the basic lifing analysis paragraph AMC E 515 (3) (d) (iv), reference is made to applying an agreed safety margin to a burst result. **Justification:** There will always be some variation in crack growth due to fluctuations in actual stress, actual temperature and actual flight profile which the fracture mechanics calculation cannot completely embody. It has in the past therefore been customary to apply a safety factor to the final result to account for these possible variations.	**Proposed Text (if applicable):** Demonstrate that the Surface fracture mechanics life, *with an appropriate factor of safety on burst life applied,* for all critical parts,.....			Not Accepted	As explained in EASA response to comment 6. above, the concept is considered to provide an appropriate level of safety when complying with the simple assumptions of the deterministic surface fracture mechanics approach. Therefore, no additional safety factor needs to be considered.

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20	*UK CAA*		6	**Paragraph No:**A2 2. **Comment:** Reference is made to establishing a monitoring process to record damage that..... is made available to the Type Certificate holder .... **Justification:** The EASA regulations allow other organisations to design and introduce alternative critical parts to a TC holder's product through the STC route. This route has already been used for approving alternative critical parts.	**Proposed Text (if applicable):** ..... is made available to the Type Certificate Holder or Supplemental Type Certificate Holder as appropriate....			Accepted	Paragraph 3.1 A1. 2. has been amended accordingly.
21	*Snecma*	§3.2	7/8	§3.2 says that the CM is applicable for "Applicants for a change to an engine Type Certificate when this change *affects compliance with CS-E 515*. » An applicant for any change to an engine TC that affects compliance to CS-E 515 should not be bound to apply the Certification memo in all cases : - The applicant may apply JAR-E 515 or an earlier JAR-E paragraph as inscribed in the Certification Basis when the Change is not significant per Part 21.A.101. - The applicant may apply already CS-E 515 but have a CRI for surface damage tolerance incorporated in its Certification Basis some years ago with some different terms from the Certification Memo. The benefit of applying the latest Certification Memo may be disproportionate to the extent of the modification.	Proposed text : Applicants for a change to an engine Type Certificate when this change *requests update from an earlier amendment of the airworthiness code to CS-E 515 per Part 21.A.101*.	No	Yes	Not Accepted	This CM represents EASA policy material and will be considered on an individual basis by EASA and the applicant.
22	*Snecma*	§1.1	4/8	In §1.1 we suggest to replace "material sub-surface anomalies" by "material anomalies" which is the terminology used in CS-E 515. We also suggest replace "defects" by "anomalies" in this § and the rest of CM.	Proposed text for the last § of §1.1: "Damage tolerance for material anomalies is not considered in this Certification Memorandum. The risks presented by these anomalies are addressed by industry standard process control and inspection strategies, which aim to eliminate these anomalies during manufacture. »	Yes	No	Not Accepted	Reference to sub-surface anomalies is made to distinguish between damage types. With respect to the purposes of the CM no difference in the meaning between "defect" and "anomaly" is identified.
23	*Snecma*	§3.1	5/8	We suggest to replace "defect" by "anomaly"	Proposed text for the 1st sub paragraph of the 1st § : Firstly a minimum level of damage tolerance capability should be established for each critical component using a deterministic approach based on a defined maximum anomaly size**.**	Yes	No	Not Accepted	See EASA response to comment 22. above.
24	*Snecma*	§1.1	4/8	The last § of §1.1 states in the 1st sentence that the CM is not about "material sub-surface anomalies" and explains the reasons for this in the 2nd sentence but finally in the last sentence expresses a requirement regarding these anomalies. This last sentence appears to contradict the intent of the 1st sentence. We suggest to remove this last sentence.	Proposed text for the last § of §1.1: "Damage tolerance for material anomalies is not considered in this Certification Memorandum. The risks presented by these anomalies are addressed by industry standard process control and inspection strategies, which aim to eliminate these anomalies during manufacture. »	No	Yes	Partially Accepted	See EASA response to comment 3. above.
25	*Snecma*	§3.1	6/8	In §A2, numbered alinea 3. , it is stated "3. Assess damage meeting the criteria defined in 2 above." Ambiguous: Alinea 2. refers to a full process, whereas damage is the result of the process.	Proposed text : 3. Assess damage *as recorded through the process defined in 2 above*.	Yes	No	Not Accepted	The actual paragraph in the CM is clear and equivalent to the proposed text.

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26	*Honeywell Aerospace*	Section 1.1 and Document Title		The first paragraph states that this CM provides "…specific guidance for applicants when demonstrating compliance with CS-E 515 (a) which requires that "appropriate Damage Tolerance assessments must be performed to address the potential for Failure from material, manufacturing and service-induced anomalies within the Approved Life of the part" …" The next paragraph clarifies that it is specifically focused on "… addressing *surface* damage tolerance in critical rotating parts ". However, the third paragraph includes the following statement "…The risks presented by these *(i.e. material sub-surface)* anomalies are addressed by industry standard process control and inspection strategies… " This implies that damage tolerance assessment of such (material sub-surface) anomalies may not be required, which is in contraction with the FAA AC33.70-1 guidance. Since this document is clearly focused on surface anomalies, it is recommended that the last two sentences in the third paragraph of Section 1.1 be deleted. Thus the third paragraph would only say: "Damage tolerance for material sub-surface anomalies is not considered in this Certification Memorandum." To further reinforce the document's focus on surface anomalies, the following edit of the document's title is recommended: "**Engine Critical Parts - Damage Tolerance Assessment of Surface Anomalies**"				Partially Accepted	See EASA response to comment 3. above.
27	*Honeywell Aerospace*	Section 3.1, Part B3, Last Paragraph		Acceptable risk levels for probabilistic damage tolerance risk assessment are referenced in the document as "…safety objectives of CS-E 510 (a)(3) ". However, CS-E 510(a)(3) states that "… the probability of a Hazardous Engine Effect arising from an *individual failure* can be predicted to be not greater than 10^{-8} per Engine flight hour…". This is different from the AC guidance with respect to acceptable design target risk for a specific (individual) failure mode for a given engine component. It is proposed that EASA consider better harmonizing the *quantitative* risk targets for probabilistic damage tolerance assessment referenced in this CM document with the corresponding FAA advisory materials.				Not Accepted	See EASA response to comment 4. above.