European Union Aviation Safety Agency

Comment-Response Document (CRD) to CPTS-0000358 issue 1

Comment Response Document (CRD) to Equivalent Safety Finding (ESF) ref. CPTS-0000358 issue 1 on Use of laboratory test rigs for the rotor drive system and control mechanism tests

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1. Summary of the outcome of the consultation

EASA received 28 comments from OEMs, authorities, industry associations and individuals. The comments were individually assessed and led to changes of the ESF whenever deemed appropriate to ensure the suitability of the content. Most comments suggested clarifications to the definitions and the applicability.

The respective assessments and comment resolutions are provided in section 2 of this document.

2. Individual comments and responses

In responding to the comments, the following terminology is applied to attest EASA's position:

(a) **Accepted** — EASA agrees with the comment and any proposed change is incorporated into the text.

(b) **Partially accepted** — EASA either partially agrees with the comment or agrees with it but the proposed change is partially incorporated into the text.

(c) **Noted** — EASA acknowledges the comment, but no change to the text is considered necessary.

(d) **Not accepted** — EASA does not agree with the comment or proposed change.

2.1. CRD table of comments, responses and resulting text

(General Comments)	-

comment	*21* comment by: *Transport Canada - Projects* A general comment that a recommendation that distinction is made between change (21.A.101) viz new type design (21.A.15) and that guidance be provided about similarity credit when demonstrating compliance for changes to the drive system instead of being part of an ELOS/FES.
response	Noted This ESF focuses on changes to the type design while CPTS-0000357 focuses on new type designs.

comment	*22* comment by: *FOCA (Switzerland)* Thank you for the opportunity to comment. We have no remarks on this document.
response	Noted

comment	*23* comment by: *AIRBUS HELICOPTERS* First of all, Airbus Helicopters would like to thank EASA for giving us the opportunity to comment on this ESF. **Airbus Helicopters comment :** Airbus Helicopters suggests EASA to contact FAA to harmonise their position regarding CS 29.923(a)(2) interpretation and to issue an equivalent generic issue paper ELOS. **Justification for the comment :** Issuance of a CRI ESF is a temporary solution which does not prevent further discussion in the frame of Foreign Validations. FAA SEI update would be necessary to ensure that the proposed ESF is recognised by FAA without any further FAA involvement in the frame of certification.

response | Noted

EASA was, is and will remain in contact with FAA for this subject. However, it cannot be guaranteed that EASA and FAA positions will be harmonised.

Please refer to comment 42 from FAA to see where current discussions between authorities stand.

comment | *24* comment by: *AIRBUS HELICOPTERS*

Airbus Helicopters comment :
Airbus Helicopters suggests that EASA launches a RuleMaking Task to implement the content of the proposed ESF into the CS29 regulation.

Justification for the comment :
What prevents an evolution of CS29.923(a)(2) by adding an exception as for CS29.927(e)?

response | Noted

EASA is considering rulemaking on CS 29.923 for the use of alternative test means. The need for a dedicated rulemaking task is still to be decided.

In any case, pending the introduction of the notion of alternative test means in CS 29.923, the activities foreseen for the applicant for compliance demonstration are not impacted.

comment | *40* comment by: *General Aviation Manufacturers Association (GAMA)*

GAMA/ASD would like to thank EASA for the opportunity to provide comments to this consultation paper. Due to limited available time to coordinate discussions, GAMA/ASD could not consolidate an industry position; in consequence, it was agreed that member companies would log their own company comments individually.

Nonetheless, in due consideration of this consultation's relevance, GAMA/ASD would like to request that EASA organize a workshop where submitted comments can be jointly reviewed and discussed with industry representatives. GAMA staff remains available to help support this request if and when accepted.

response | Accepted

The workshop was organized and the opportunity was given to relevant companies to review and comment on the updated draft prior to publication.

comment | *41* comment by: *Vertical Aerospace*

Whilst it is recognised that these documents are CS-29 documents, their applicability is wider than just Helicopters as we are seeking to use them for our eVTOL aircraft. Please can the terminology be changed to reflect the fact that it is just not applicable to Helicopters.

response

Not accepted

The term “helicopter” is only used once in the ESF for the use of test rigs. The instance in which this term is used is referring to the particular case of this rotorcraft configuration. Nevertheless, the scope of the ESFs remain the same as for CS-29, large rotorcraft.

It should be noted that the use of CS-29 and any associated policies such as this ESF need to be assessed individually for their suitability for certification of other aircraft categories. Such assessment would need to be performed at project level.

comment

42 comment by: *Federal Aviation Administration*

FAA comment:

The FAA recommends maintaining the current regulatory processes for requests to perform 14 CFR 29.923 endurance testing utilizing a test rig, rather than implementing this new ESF proposal.

In the FAA’s certification process procedures, it would not be appropriate for the FAA to issue a general ELOS policy to cover 14 CFR 29.923 Alternative Test Means similar to EASA’s. The FAA will continue to maintain 29.923 certification standards, associated AC material, and handle any applicant proposals for alternative 29.923 testing on a case-by-case basis. The FAA will continue to evaluate such applicant proposals accordingly, and only issue an ELOS finding if the applicant includes appropriate compensating factors.

Per § 14 CFR 29.923(a)(2) Rotor drive system and control mechanism tests “The tests must be conducted on the rotorcraft”. The FAA maintains that this regulation assures the highest integrity of safety and assurance by subjecting newly designed and redesigned rotor drive systems to real world testing environments. Rotorcraft based testing will show how system(s) behave both individually and interact with other systems and components revealing issues and/or concerns which may not have been anticipated or apparent given previous analysis using other testing means.

The FAA maintains that a shift in this policy has the potential to negatively impact safety standards by compromising the prescriptive nature of §14 CFR 29.923. The FAA has determined that certain language within the proposed EASA ESF is ambiguous with respect to the definition of what constitutes a design change that is not considered to be substantial. Furthermore, the EASA ESF breaks down applicability into two categories in order to perform lab-based rig testing, permitting physical design changes based on “extensive return of experience”, and allowing limited/local design changes to rotor drive and control mechanisms with no requirement for the applicant to have any “return of experience”. These two separate categories of applicability will have precedent setting ramifications by allowing rotor drive systems a path to certification that is not yet well understood.

§14 CFR 29.923(c) prescribes that, “The loads, the vibration, and the methods of application to the affected rotor drive system components must be representative of the rotorcraft conditions. Test components must be those used to show compliance…”.

The FAA does not believe that applicants will be able to realistically meet the criteria outlined under the section c(3), Compensating Factors. The capability to accurately model and simulate all interfaces, wear, materials, and dynamic loads, as well as other key boundary conditions necessary when utilizing test rigs may not be possible. Presently, test rigs being used for this purpose, were originally intended for research and development purposes, and to verify the mechanical operation of gearboxes post assembly. Rig testing apparatuses similar to the aforementioned lack the ability to sufficiently replicate Rotor Control Inputs, such as those required per 14 CFR 29.923(c). Although more complex test rig apparatuses do exist and may feature the capability to introduce simulated control inputs, test setup and configuration of rotorcraft gearboxes on test rigs which are not categorized as a "partial aircraft" require substantial use of non-OEM parts and components such as drive shafts, structure/structural components, accessory drive systems, lubrication systems, and hardware. These non-OEM components required for bench testing can introduce non-representative mechanical behavior and boundary conditions when compared to the complete installation per the rotorcraft's type design.

The use of non-OEM parts and components for endurance testing purposes, cannot be categorized as nonconforming features, and must require substantiation to establish compensating factors in order for the FAA to support an ELOS finding. Depending on the scope of an applicant's design change, it is possible that the FAA may not find the utilization of a test rig, or combination of these non-OEM components appropriate for endurance testing certification purposes. In cases such as this, the FAA and EASA will not be harmonized with respect to the applicant's approach to a means of compliance.

response

Noted

EASA will continue to pursue harmonization with the FAA on this subject by means of bilateral discussions.

Regarding the different items addressed in this comment:

- EASA does not propose any change to regulatory processes. This ESF reflects current rotorcraft industry practices for compliance with CS 29.923. As such this ESF has been issued for a number of projects for achieving certification objectives equivalent to those of CS 29.923(a)(2). More specifically EASA has used this approach on 5 projects involving changes to rotorcraft main gearbox, some of which are in the process of validation with the FAA. It is expected that through the validation of these changes FAA will gain greater understanding of the approach described in this ESF.
- EASA considers that the compensating factors specified in these ESF adequately ensure an equivalent level of safety to tests that directly follow CS 29.923(a)(2).
- Please note that the sections of the ESF referring to "extensive return of experience" have been amended to enhance clarity.
- As stated in ESF CPTS-0000358, "parts under test may be reduced and limited to the ones affected by the modification". This refers not only to the part(s) subject to the design change but also to any part that may be

	impacted by and/or that may impact the part(s) subject to the design change.

IDENTIFICATION OF ISSUE: p. 2

comment	*25* comment by: *AIRBUS HELICOPTERS* With regard to the penultimate paragraph of the Identification of Issue on page 3 : "*EASA considers that using laboratory test rigs as endurance test means cannot be simply considered as a nonconforming **feaure** of the prescribed rotorcraft and must be considered as an alternative test means. [...]*" **Typo** : replace "*feaure*" by "*feature*"
response	Accepted – Text has been corrected accordingly.

1. APPLICABILITY p. 4

comment	*2* comment by: *DE-LBA* Original text: "design changes which do not consist in a **substantial modification**" Comment: The ESF introduces the term "substantial modification", which is not in line with current Part-21 terminology. - To which extent shall this classification (substantial / not substantial) be formalised and documented?
response	Accepted The term 'substantial modification' has been removed. Now this is described by highlighting the typical characteristics of changes for which this ESF is considered applicable and also providing a list of examples.

comment	*4* comment by: *DE-LBA* Original text: "A design change is deemed not to constitute a substantial modification [...] a) [...] for which an extensive return of experience is available." Comment: The criteria presented in this section could be interpreted as follows: If positive service experience is available for a well-proven design, then every change could be classified as a "non-substantial modification". It seems somewhat odd to assess the potential impact of a change solely on the basis of experience with the old design. How can you be sure that the design change does not introduce new sources of failure not covered by past service experience with the old design? - Assuming that this is not the real intent of this ESF, we suggest to improve the wording.
response	Partially accepted The definition of the changes for which this ESF is considered applicable have been simplified and examples have been added for clarity.

comment	*17* comment by: *Amedeo Marzano* The definition of "***substantial***" referred to design changes to the rotor drive system and/or rotor control mechanism, doesn't match with the one described in Appendix A to GM 21.A.101 where a different definition for "substantial change" is available. We believe this mismatch could create mistakes and misunderstandings. Suggested Recommendation : In order to avoid misinterpretation and mismatch with 21.A.101 and relative GM and Appendix A, we recommend replacing substantial with "appreciable".
response	Partially accepted The term 'substantial modification' has been removed to avoid confusion with Part 21 terminology.

comment	*18* comment by: *Amedeo Marzano* We believe that it is necessary to provide examples of what is intended as " limited or locals" in order to ensure a common understanding and level playing field. Suggested recommendation To better explain what is intended for limit and local change by adding possibly examples : (e.g MGB internal lubrication improvements; MGB alternative lubricating oil; MGB alternative internal bearing qualification)
response	Accepted Examples have been introduced in the text.

comment	*26* comment by: *AIRBUS HELICOPTERS* With regard to the first sentence of the paragraph #1 - Applicability : "*This ESF is applicable to large rotorcraft for design changes which do not consist in a substantial modification to the rotor drive system and/or rotor control mechanism.*" **Airbus Helicopters proposed text :** Airbus Helicopters suggests to change the above sentence as follows : "*This ESF is applicable to large rotorcraft for design changes where the design of the rotor drive system and/or rotor control mechanism is not substantially modified.*" **Justification for the comment :** It has to be clarified that the term "substantial" is not equivalent to the one used in PART 21.A.101 to classify a design change at H/C level.
response	Partially accepted

	The term 'substantial modification' has been removed to avoid confusion with Part 21 terminology. However, the exact wording proposed has not been incorporated.

comment	*27* comment by: *AIRBUS HELICOPTERS* With regard to the paragraph #1.a) - Applicability : "*A physical design change and/or extension of permitted operating conditions impacting parts of the rotor drive system and/or rotor control mechanism for which an extensive return of experience is available*" **Airbus Helicopters comment:** This ESF should provide more details regarding expectations to meet the "*extensive return of experience*" condition
response	Partially accepted. The term 'extensive return of experience' is no longer used to avoid confusion. The definition of the applicability of the ESF has been simplified and examples added.

comment	*28* comment by: *AIRBUS HELICOPTERS* With regard to the paragraph #1 - Applicability : **Airbus Helicopters proposed text :** Airbus Helicopters suggests to add a new bullet "*c)*" as follows : "*c) any other change for which testing conducted at H/C level or on Iron bird is not appropriate.*" **Justification for the comment :** This new bullet will open the usage of test rigs to some other cases not directly falling under bullets (a) and (b).
response	Accepted The text indicated has been removed and further clarification added.

comment	*29* comment by: *Leonardo Helicopters* A better definition of "substantial modification" is required for a correct application of the ESF. An AMC or GM with the related definition could be considered, if possible including examples of modifications classification.
response	Partially accepted Associated Means of Compliance have been added providing examples. In addition, the applicability is no longer defined using the term "substantial modification".

comment	*30* comment by: *Leonardo Helicopters*

	A definition of "limited" and "local" of point b) is required for a correct application of the ESF. An AMC or GM with the related definition could be considered.
response	Partially accepted Associated Means of Compliance have been added providing examples. In any case it should be evident that ultimately the key aspect is to justify adequate compensating factors as described in section 3 of the ESF.

comment	*31* comment by: *Leonardo Helicopters* It is unclear the contribution of in-service experience to the definition of the change classification.
response	Accepted The relevance of experience to evaluate the applicability of this ESF has been clarified. In addition, examples of changes for which the ESF could be applicable have been added in appendix.

comment	*32* comment by: *Leonardo Helicopters* A more clear/quantified definition of "enough return of experience" is required for a correct application of the ESF. Also, how to correlate the field experience to the test rig conditions is unclear. An AMC or GM with the related definition could be considered.
response	Accepted The relevance of experience to evaluate the applicability of this ESF has been clarified. In addition, examples of changes for which the ESF could be applicable have been added in appendix.

3. COMPENSATING FACTORS p. 4

comment	*3* comment by: *DE-LBA* Original text: "ii) Any potential degradations, such as wear or fretting, that could appear during the endurance tests, must be demonstrated to be similar to those that would occur by testing on the rotorcraft." Comment: To make such a statement in a well-founded way, wouldn't it require comparative testing in both ways (test rig AND rotorcraft)?
response	Accepted Rewording has been introduced to improve the clarity of this statement. In any case, the point is simply to ensure that the rig is capable of simulating conditions experienced in the rotorcraft, potentially leading to degradation of components

	under test. Once this is confirmed, then comparison between the existing and modified design can be performed based on rig test results only.
comment	*19* comment by: *Amedeo Marzano* In point 3 iv) A) it is proposed "***to increase the nominal torque and load values***" in order to take into account loads oscillations and to ensure that the maximum torques and loads, including loads oscillations from the test rig(s), are at least as high as the rotorcraft ones. If adopted, this compensating measure could lead the rotor drive system to operate in different conditions with respect to real ones: bearings, couplings, gears, contact surfaces could be subject to different conditions not representative of real conditions. This compensating factor has reason to be considered only if rotor(s) and/or engine(s) and/or rotor-brake(s) from the rotorcraft type design are replaced by alternative means: but this condition seems to be already addressed by point vi) that imposes additional demonstrations in order to ensure that torques and loads, including loads oscillations in the test rig(s) are representative as the rotorcraft ones. Suggested Recommendation Delete point 3 iv) A).
response	Not accepted Point 3) iv) A) addresses the compensation of oscillating loads when alternative means to engines and rotors are used to introduce and absorb torque and loads during the endurance test. In case of conventional helicopters using conventional turbine engines, the impact of oscillating rotor torque and loads is well understood and usually low. In such case, EASA considers the oscillations of torque and load at a given power setting can be accounted for in rig tests using electric motors by ensuring the maximum torques and loads caused by these oscillations are replicated in the bench.
comment	*20* comment by: *Amedeo Marzano* It is not explicitly indicated the need to ensure that relative deformations of the parts under test and their surrounding test rig elements be fully representative of the deformation/displacement experienced by the same parts when installed on the helicopters. Please consider that we are not addressing here imposed external deformation or misalignment but the relative deformation of drive system components under the applied loads. In other words, even in case of appropriate external loads application , there is a risk of not properly loading the parts under test, should the stiffness of the test rig interfacing with the parts in question, not be correctly simulated Suggested recommendation : It is proposed to amend point 3i) as follows : The applicant must ensure that the loading conditions and deformations of the parts under test are representative of the rotorcraft configuration.

response	Not accepted EASA considers that by stating that “The applicant must ensure that the loading conditions of the parts under test are representative of the rotorcraft configuration” it is already sufficiently clear that this does not refer only to external loading, but also internal component loading (i.e. component stresses). EASA has used this ESF in the past and this has never been found to be a topic requiring further clarification.

comment	*33* comment by: *Leonardo Helicopters* The sentence "the applicant must formally identify the parts that are affected by the modification and intended to be endurance-tested and provide associated justifications" is unclear. Is the justification is intended to be relevant to the classification of the modification for the subject parts? If so, the assessment should not be limited to the parts affected by the modification, but to the surrounding and mechanically&functionally interfacing parts as well.
response	Not accepted “Affected” refers to both directly physically affected by the change and those that are impacted as a consequence of this change.

comment	*34* comment by: *Leonardo Helicopters* The point "iii) The interface properties to be considered must include: materials, surface treatments, dimensions (e.g. shape, contact areas, surface roughness), fitting conditions (e.g. means of attachments, tightening loads) and lubrication conditions (e.g. quantity and type of lubricants used for fasteners)." could be not relevant if the component under test is inside, for example, the gearbox housing. It is recommended to delete point iii) and address inside point i) the related assessment.
response	Not accepted Whenever this point is not relevant due to the parts under interface properties of the parts under test being clearly and fully reproduced, this point is satisfied. Thus, the concern from commenter is not shared.

comment	*35* comment by: *Leonardo Helicopters* The sentence "The applicant must ensure that rotorcraft environmental conditions are representatively introduced for the parts under test (e.g., oil flow and temperature for lubricated gears and bearings)." is misleading, also the oil temperature is not an environmental condition. It is recommended to replace "environmental conditions" with "operating conditions".
response	Not accepted

	The comment is understood to highlight a risk of “environmental conditions” being understood as referring only to the external environment in which the test is conducted. However, this point clearly refers to the environmental condition of each part under test. For a gear or bearing inside a gearbox the main environmental conditions affecting their operation correspond to the lubricating conditions. This is not considered questionable or misleading. In addition, operating conditions is considered a more generic term, including other aspects such as loading which are addressed in other points.
comment	*36* comment by: *Leonardo Helicopters* The sentence "A compensating measure that is considered as acceptable is to increase the nominal torque and load values on the test rig(s) in order to ensure that the maximum torques and loads, including loads oscillations from the test rig(s), are at least as high as the rotorcraft ones." could lead to partial or not representative conditions. For example, load pattern on gears and bearing changes with respect to the real behaviour. It is recommended to define more extensive examples of acceptable compensating measures. An AMC or GM with the related definition could be considered.
response	Partially accepted The request of this point is to ensure the maximum loads corresponding to each condition are covered in test. This is not to be considered as exceeding the nominal rating or to lead to unrepresentative conditions. The applicant can propose a different approach as this is just an option to do so as evidenced by the fact that this is now in Associated Means of Compliance to the ESF. Also, as stated in b. directly below the point commented, justifying that these oscillations do not have an impact is also viable. In any case, to ensure the approach proposed is clear, the approach has been clarified by adding a graph the illustrates how it can be implemented.
comment	*37* comment by: *Leonardo Helicopters* Point vi) "When rotor(s) and/or engine(s) and/or rotor brake(s) from the aircraft are replaced by [...]" is unclear. A test rig with rotor(s) and/or engine(s) is intended to fall within ESF CPTS-0000357.
response	Noted ESF CPTS-0000357 addresses tests that feature (at least): - the structures directly supporting the rotor drive systems and rotor control mechanism, - the rotor and rotor drive systems, - the engines and engine installations. Any other test means used for compliance with CS 29.923 is addressed by this ESF (CPTS-0000358).

comment	*38* comment by: *Leonardo Helicopters* The closed-loop test rig could be either mechanical and/or electrical one. Is the same compensating factor applicable to both cases?
response	Accepted The same objective applies to any test rig. This has been clarified in the revised text.

comment	*39* comment by: *Leonardo Helicopters* It is unclear if the complementary ground/flight test for the closed-loop test rig are to be considered a validation mean or an actual campaign with extensive data analysis. An AMC or GM with the related definition could be considered.
response	Not accepted. It is additional testing complementing that performed in the closed-loop test rig to show compliance with all test phases of CS 29.923. What is needed from such complementary test would depend on the actual modification, extent in which parts are affected and capabilities of the rig. Detailed guidance on such testing could not be developed at this stage. Nevertheless, the purpose of this text is considered sufficiently clear and the details will be discussed case by case.