**NPA 2021-01**

# Rotorcraft chip detection systems

## RMT.0725 — Subtask 1

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
The intended scope of this NPA is unclear, i.e. whether it is to mandate only chip detectors, any type of on-board oil debris monitor (ODM) device (whichever device is most suitable for each monitoring application), or all means of ODM including off-wing methods (e.g. Spectometric Oil analysis Programme).

If it is the intention of the NPA that 29.1337(e) addresses only chip detectors and then that the 29.917(b) safety assessment can determine where other means of ODM are found to be more effective and necessary for particular applications / failures, then we recommend this to be clarified in the advisory material.

**Justification:**
We would hope that the intention of this NPA would be to improve the performance and confidence in the means adopted by TCHs to monitor degradation in rotorcraft gearboxes and embrace new technology where this can help achieve this objective.

The NPA currently reads as though it is restricting the choice of ODM to chip detectors, which we believe will not perform as well as newer methods of ODM for certain failure mechanisms. To require chip detectors to be used as the only means of ODM to comply with 1337(e) may hinder industry from developing more effective means of ODM.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
If other means of oil debris monitoring are to be considered by this NPA, then we recommend EASA to consider replacing the term “Chip Detection System” with “Oil Debris Monitoring System”.

**Justification:**
“Chips” are clearly visible particles. Sometimes smaller micro-particles are generated earlier in the failure process. A chip detector warning can potentially take many hours for the chip plug gap to be bridged by smaller particles, however, other means of ODM can provide health data after each flight.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
We recommend that it should be considered whether a “Chip Detection System” that complies with this NPA would have had a reasonable chance of preventing recent accidents including G-REDL, G-REDW, G-CHCN, LN-OJF.

**Justification:**
As Norwegian AIB recommendation NORW-2018-004 was made following the accident of LN-OJF, we believe preventing a similar accident should be included as a foundation of this rule-making task.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
Chip detection is only reliable if the degradation of the component is relatively slow and produces a relatively large number of medium or larger size particles. If the final stages of degradation are too quick or a low number of magnetic particles are produced, then other means of ODM may be more effective.

The text of this NPA infers that the scope of monitoring is limited to identification of “chips”. In order to benefit from monitoring micro-particles, we believe the NPA should consider referring to “debris” instead of “chips”.

**Justification:**
Other means of ODM can monitor smaller particles (sometimes generated due to initial wear earlier in the failure process) and provide health indication data after each flight, as opposed to waiting potentially many hours for a chip plug gap to be bridged.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
The meaning of the terms “chip detector” and “chip detection system” in this NPA is unclear. There are a number of terms used throughout this NPA that would benefit from being more accurately defined. Proposed definitions are as follows:

a. *Aggressive Wear*: Wear which is occurring at a rate which is higher than that normally expected, or which may indicate damage that could affect design assumptions regarding component reliability or structural integrity.

b. *Chip Detection System*: Any means of detecting and/or monitoring ferromagnetic particles in an oil system (pressurised or unpressurised “splash lubricated”).

c. *Chip*: Sizeable piece of ferromagnetic material, e.g. spalling debris or built-in debris from the manufacturing process. Historically chips have been easily visible (>500 µm effective diameter) with the naked human eye.

d. *Debris*: Means any ferromagnetic particles resulting from damage including wear of elements within the gearbox, including smaller micro-particles, such as “sludge”, “paste” or “fuzz”, which can be an advanced indicator of normal or abnormal wear.

e. *Detection*: Means detection with respect to providing the capability of early warning regarding the condition of components associated with the failure modes for which oil debris monitoring has been identified as a compensating provision.

f. *Effectiveness*: Means the capability to provide an early warning regarding the condition of components associated with the failure modes for which oil debris monitoring has been identified as a compensating provision.

g. *Gearbox*: Means each rotor drive system gearbox and associated lubrication system, including each gearbox module which relies on an independent chip detection system.

**Justification:**
Correct understanding of these terms is a prerequisite to achieving the intent of this requirement.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
|---|---|

General Comment

**Comment:**
29.1337(e) is applicable to “rotorcraft rotor drive system transmissions and gearboxes”. If EASA consider that this NPA is only relevant to applications which have an oil system, then this consequently limits the applicability to gearboxes. In this case the requirement and associated AMC should refer only to “gearboxes” and not “transmissions and gearboxes”.

**Justification:**
Gearboxes are a subset of transmissions. Therefore, the NPA should state either “transmission” or “gearboxes”. However, only gearboxes have an oil system, which is necessary for a chip detection system to function, in which case it is more accurate to state “gearboxes”.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
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General Comment

**Comment:**
If 29.1337(e) refers to “chip detection systems”, then 29.1305 should also refer to “chip detection systems” rather than “chip detectors”. If EASA decide that the scope of this NPA should address other means of ODM in addition to chip detectors, then both 29.1337(e) and 29.1305 should refer to “oil debris monitoring systems”.

**Justification:**
29.1337(e) and 29.1305 should utilise consistent terminology.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
|---|---|

General Comment

**Comment:**
The NPA only applies the method of demonstration of the performance of ODM systems to systems which are both identified as compensating provisions for compliance with 29.917(b) and where used for compliance with 29.1337(e). Though often the same ODM system will be used for compliance with 29.917(b) and 1337(e), sometimes other chip detectors (or “mag plugs”) are used to monitor individual gearbox modules or other locations in the oil system. We recommend the NPA should be clear whether compliance with 29.1337(e) will require that;

a. all chip detection systems identified in 29.917(b) become the subject of 29.1337(e), or
b. only one chip detection system per gearbox is needed to satisfy 29.1337(e), or
c. at least one chip detection system should be provided, and its effectiveness substantiated, for every gearbox or gearbox module for which the safety assessment has identified potentially hazardous or catastrophic failure conditions.

**Justification:**
The current NPA does not appear to clearly address multiple chip detectors, chip detectors without cockpit indication, and the possibility of different gearbox modules needing their own dedicated means of ODM.

**Proposed Text:**
See miscellaneous proposed changes in later UK CAA comments.

| **Commentor:** | UK CAA |
|---|---|

General Comment

**Comment:**
This NPA references Norwegian AIB recommendation NORW-2018-004, which was raised following an accident involving spalling of a bearing race, involving a gear with an integrated bearing race. A large spall particle might have a mass in excess of 20 mg. Consequently, if the test described in AMC 29.1337 proposes releasing 60g of debris, this might represent an unacceptably small number of spall particles. The NPA should be clear that the mass of debris used for a test should be selected such that there is a sufficient number of representative particles to achieve a statistically significant test result.

**Justification:**
Testing prescribed should achieve statistically significant results.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

General Comment

**Comment:**
AMC 29.1337 (2) states that gearbox debris detection performance “must be demonstrated”. The terminology “must”, is usually limited to use in the specification rather than advisory material.

**Justification:**
Text should be consistent with defining a method of compliance.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

General Comment

**Comment:** General comments and miscellaneous changes proposed with respect to CS 29 and associated AMC should also be considered for CS 27 where accepted by EASA.

**Justification:** Consistency

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 1

**Paragraph No:** N/A

**Comment:**
The NPA is specifically focused on chip detection systems, we believe the NPA should be focussed on monitoring degradation in the rotorcraft gearboxes rather than concentrating on chip detectors.

**Justification:**
To support industry to develop effective means of degradation monitoring.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 5

**Paragraph No:** 1st paragraph

**Comment:**
We recommend it is stated that the main gearboxes are not closed systems thus the operational environment within the gearbox can't be closely controlled.

**Justification:**
This could lead to imprecise understanding of the degradation and failure mechanisms of the gearbox components.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 5

**Paragraph No:** 2nd paragraph

**Comment:** The final sentence of the 2nd paragraph states: "*These particles are typically released by gearbox components when they are worn or damaged, and are therefore considered to be a reliable way of detecting when elements of the system are no longer in a serviceable condition*" . We believe this is factually incorrect.

**Justification:**
There have been 2 accidents and 29 fatalities that have shown that chip detection systems in rotorcraft are fallible. Chip detection is only reliable if the degradation of the component is relatively slow and produces a relatively large number of particles. If the degradation is rapid or a low number of magnetic particles are produced during the degradation then a chip detection system is likely to be ineffective.

Additionally, we believe the stated objective of the system is not enough, the monitoring system must detect the degradation whilst the components are in a serviceable condition.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 5

**Paragraph No:** 6th paragraph and throughout

**Comment:**
We recommend the term "excessive wear" should be replaced with "aggressive wear" throughout the amendment text.

**Justification:**
"Wear" has a number of meanings, damage mechanisms arising from the motion of 2 contacting surfaces in respect of each other and the damage caused by these mechanisms. If a reader interprets it as the damage caused, then there is an issue. It would be expected that the chip detection system would identify active wear mechanisms before excessive wear damage has occurred.

A clear use of language is recommended making it clear to the reader that "wear" is a damage mechanism and "excessive" is to be replaced by "aggressive". Additionally, the term "aggressive wear" is defined within the GM or AMC text.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 9 and 17

**Paragraph No:** CS 29.1337 (e) and CS 27.1337 (e)

**Comment:**
The proposed requirement uses the term "effectively". We believe terms like "effectively" should not be used in regulations or certification specifications.

**Justification:**
If in the future there is any accident due to a chip detection system failing to detect degradation and impending failure of a gearbox, then EASA could be criticised as it did not ensure that there was an

effective chip detection system.

**Proposed Text:**
Recommend EASA to either delete the term "effectively" or define what is considered to be effective.

The proposed requirement also uses the term “excessive wear” which should be replaced by the term “aggressive wear” as suggested in UK CAA previous comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 9

**Paragraph No: CS 29.1337 Powerplant Instruments**

**Comment:**
Miscellaneous changes are proposed to the NPA text as detailed below.
— text proposed to be deleted by CAA is ~~struck through in red and highlighted in yellow~~;
— new or amended text proposed for introduction by CAA is in red and highlighted in yellow.
— deletions proposed by EASA are struck through in red and new or amended text proposed by EASA are highlighted in blue for ease

**Justification:**
We believe that replacing the terms in the proposed text section below, using the suggested definition in the earlier UK CAA comment, would aid the correct understanding and intent of this requirement.

**Proposed Text:**

**CS 29.1337 Powerplant Instruments**
[…]
(e) *Chip detection system*. Rotor drive system ~~transmissions and~~ gearboxes utilising ferromagnetic materials must be equipped with *chip* ~~*detectors*~~ *detection systems* designed and demonstrated to ~~effectively~~ indicate the presence of ferromagnetic particles resulting from damage ~~or excessive~~, including *aggressive wear*, within each ~~the transmission or~~ gearbox, or gearbox module, failure of which could result in hazardous or catastrophic effect. Each *chip* ~~*detector*~~ *detection system* must:

1.Be designed to provide a signal to the indicator required by point (a)(23) of CS 29.1305~~(a)(23)~~; and
2.Be provided with a means to allow crew members to check or to be informed of, in flight, whether the electrical circuits and signals of the *chip* ~~*detector(s) detection system(s)*~~ are functioning correctly. ~~function of each detector electrical circuit and signal.~~

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 9

**Paragraph No:** N/A

**Comment:** We believe CS 29.1305 (as referred to in CS 29.1337(e)(1)) should be amended as proposed below.

**Justification:** Consistency of terminology

**Proposed Text:**

**CS 29.1305 Powerplant instruments**
[…]

(23) Warning or caution devices to signal to the flight crew when ferromagnetic particles are detected by the *chip* ~~*detector*~~ *detection system* required by CS 29.1337(e); and …

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 13

**Paragraph No:** AMC No 2 to 29.917, Rotor drive system design

**Comment:**
We question whether the means of compliance detailed in AMC No 2 to 29.917 sufficient to prevent another G-REDL or NL-OJF accident.

**Justification:**
During the G-REDL accident the chip detection system recorded a chip four minutes prior to the loss of the rotor-head. Due to the use of subjective terminology an applicant could deem a chip detection system with similar efficiency as compliant.

Additionally, there does not appear to be consideration of "human factors" such as the non-recognition of critical degradation after first chip detection.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 13

**Paragraph No:** AMC No 2 to 29.917 (1) Rotor drive system design

**Comment:**

There are a number of terms used throughout this NPA that would benefit from being more accurately defined.

Miscellaneous changes are proposed to the NPA text as detailed below.
— text proposed to be deleted by CAA is ~~struck through in red and highlighted in yellow~~;
— new or amended text proposed for introduction by CAA is in red and highlighted in yellow.
— deletions proposed by EASA are struck through in red and new or amended text proposed by EASA are highlighted in blue for ease.

**Justification:**
We believe that the correct understanding of these terms is a prerequisite to achieving the intent of this requirement.

**Proposed Text:**

**AMC No 2 to 29.917 Rotor drive system design**

For each *chip detection system* used as a compensating provision for hazardous or catastrophic failures to meet point (b) of CS 29.917, this section introduces acceptable means of compliance to substantiate their effectiveness ~~chip detection systems specified in point (c) of CS 29.1337 as an appropriate compensating provision~~ .

(1) Definitions:

a. *Aggressive Wear*: Wear which is occurring at a rate which is higher than normal expectation or may indicate damage that could affect design assumptions regarding component reliability or structural integrity.

b. *Chip Detection System*: Any means of detecting and/or monitoring ferromagnetic particles in the oil system (pressurised or unpressurised "splash lubricated").

c. *Chip*: Sizeable piece of ferromagnetic material, e.g. spalling debris or built in debris from manufacturing process. Historically chips have been easily visible (>500 µm) with the naked human eye.

d. *Oil Debris*: Ferromagnetic particles resulting from damage or wear of elements within the gearbox.

e. *Detection*: Means detection with respect to providing the capability of early warning regarding the condition of components associated with the failure modes for which oil debris monitoring has been identified as a compensating provision.

f. *Effectiveness*: Means the capability to provide an early warning regarding the condition of components associated with the failure modes for which oil debris monitoring has been identified as a compensating provision.

g. *Gearbox*: Means each rotor drive system gearbox and associated lubrication system, including each gearbox module which relies on an independent *chip detection system*.

~~(1)~~(2) A *chip detection system* installed ~~on~~ for the purpose of monitoring a rotor drive system ~~transmission or~~ gearbox ~~for compliance with point (e) of CS 29.1337 is typically~~ and which is identified as a compensating provision in the rotor drive system design assessment may also be used for compliance with point (e) of CS 29.1337. As a compensating provision, it is intended to minimise the likelihood of occurrence of certain ~~failures in transmissions and gearboxes, including some~~ hazardous and catastrophic failures.

~~(2)~~(3) In order to be accepted as an appropriate compensating provision, the *chip detection system* must ~~effectively~~ indicate the presence of ferromagnetic particles released due to degradation, such as wear or other damage, that could lead to the failure ~~mode~~s whose occurrence the *chip detection system* is intended to minimise. As a result, when demonstrating compliance with point (b) of CS 29.917, the *effectiveness* of the *chip detection system* should be substantiated for all the ~~relevant~~ identified hazardous and catastrophic failure modes ~~should be substantiated by~~ using full-scale testing.

~~(3)~~(4) The test(s) performed for this demonstration should address all the areas of the rotor drive system associated with the failure ~~mode~~s for which the *chip detection system* is identified as a compensating provision. Point (3)(a) of AMC 29.1337 provides further guidance on the use of full-scale testing as a means for compliance demonstration for the *chip detection system* ~~and~~ as well as providing performance objectives to be met in order to demonstrate the general level of effectiveness of the system. In addition, the specific characteristics of the failure modes, for which the *chip detection system* is

identified as a compensating provision, should be evaluated to ensure that the *detection effectiveness* of point (2) of AMC 29.1337 is sufficient. For cases where the failure modes being analysed cannot be identified by the chip detection effectiveness prescribed in point (2) of AMC 29.1337 with a sufficient margin, before the occurrence of hazardous or catastrophic consequences, enhanced objectives for the demonstration of the chip *detection effectiveness* should replace those of point (2) of AMC 29.1337.

*Note:* The demonstration of the *effectiveness* of a *chip detection system* performed in support of ~~the demonstration of~~ compliance with point (b) of CS 29.917 ~~and point (e) of CS 29.1337~~ should not be considered as a means to obtain credit towards compliance with other certification specifications. ~~Robust~~ Reliable design using conservative safety margins should still be considered as the primary ~~mitigation~~ means ~~for~~ to minimise the likelihood of rotor drive system failures.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 13

**Paragraph No:** 3 - AMC No 2 to 29.917 (2), Rotor drive system design

**Comment:**
As currently proposed, the AMC No 2 to 29.917 (2) uses the term “effectively”.

**Justification:**
We believe terms like “effectively” should not be used in regulations or certification specifications. If in the future there is any accident due to a chip detection system failing to detect degradation and impending failure of a gearbox, EASA could come under criticism as it did not ensure that there was an effective chip detection system.

**Proposed Text:**
Recommend EASA to either delete the term "effectively" or define what is considered to be effective.

| **Commentor:** | UK CAA |
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**Page No:** 14

**Paragraph No:** AMC 29.1337 (2), Powerplant instruments

**Comment:**
We question whether a detection system that just meets the criteria detailed here would have prevented the G-REDL and LN-OJF accidents. considering the human factors that were involved in the G-REDL case. If the first chip detect indication is missed, there needs to be further opportunity to detect the damage before failure.

**Justification:**
The text does not appear to consider Human Factors, there is a principle within damage tolerance that there must be at least 3 opportunities for identification of the damage before the component fails.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 14

**Paragraph No:** AMC 29.1337 (2) Powerplant Instruments

**Comment:**
Regarding an interpretation of the following test criteria: At the point when wear is causing the production of 60 mg of spalled material, the chip detection system must generate a pilot warning within 20 minutes, our concern is whether with a low spalling rate with rapid rolling contact fatigue the pilot will have sufficient time to find a safe landing site.

| **Commentor:** | UK CAA |
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**Page No:** 14

**Paragraph No:** AMC 29.1337 Powerplant Instruments

**Comment:**
We recommend that other additional means of oil debris monitoring are considered in this NPA and therefore the term “Chip Detection System” is replaced with “Oil Debris Monitoring System”.

Miscellaneous changes are proposed to the NPA text as detailed below.
— text proposed to be deleted by CAA is ~~struck through in red and highlighted in yellow~~;
— new or amended text proposed for introduction by CAA is in red and highlighted in yellow.
— deletions proposed by EASA are struck through and new or amended text proposed by EASA are highlighted in blue for ease

**Justification:**
“Chips” are clearly visible particles. Sometimes smaller micro-particles are generated earlier in the failure process. A chip detector warning can potentially take many hours for the chip plug gap to be bridged by smaller particles, however, other means of ODM can provide health data after each flight.

**Proposed Text:**

**AMC 29.1337 Powerplant Instruments**

This AMC provides further guidance and acceptable means of compliance to supplement FAA AC 29-2C § AC 29.1337 to meet EASA’s interpretation of CS 29.1337. As such, it should be used in conjunction with the FAA AC.

For *chip detection systems*, the following aspects should be taken into consideration in order to demonstrate compliance with point (e) of CS 29.1337:

(1) ~~Chip~~ *Oil debris* *detection effectiveness*. The effectiveness of a chip detection system should be understood as its capability to indicate the presence of ferromagnetic particles within a ~~transmission or a~~ gearbox. Dependent on the type of chip detection system and its design, the particle capture or indication *effectiveness* may be different for different sizes or shapes of particle. Because of the nature of a *chip detection system*, which requires these ferromagnetic particles to move to the vicinity of its sensing element(s) (chip detector(s)), the *effectiveness* of the *chip detection system* is dependent upon:

— the design of the rotor drive system’~~s transmission or~~ gearbox;

— the location of the ~~chip~~ detector; and

— the design of the ~~chip~~ detector.

(2)Demonstration of effectiveness. A *chip detection system* installed in a rotor drive system~~'s transmission or~~ gearbox must be demonstrated to effectively perform its function of indicating the presence of ferromagnetic particles resulting from damage ~~or~~, including ~~excessive~~ aggressive wear, within the ~~transmission or~~ gearbox. As previously mentioned, the *effectiveness* of a *chip detection system* is also affected by the design of the ~~transmission or~~ gearbox in question and the location of the ~~chip~~ *oil debris* detectors within them. As a result, when evaluating the *effectiveness* of the *chip detection system*, the characteristics of the complete ~~transmission or~~ gearbox should be taken into account. Hence, the demonstration of the *effectiveness* of the *chip detection system* should show that the capability of the system is adequate to consistently generate a caution/warning signal within an acceptable period of time of a limited amount of ferromagnetic material in the form of representative particles being released, considering the characteristics of the corresponding ~~transmission or~~ gearbox, such as oil ways and flow paths towards the chip detectors. Concerning the level of *effectiveness* that is considered adequate to fulfil this certification specification, it is considered acceptable to show that a caution/warning signal is generated by the *chip detection system* following the release of 60 mg of ferromagnetic material from ~~any~~ each affected ~~relevant~~ area of the ~~transmission or~~ gearbox. The amount of 60 mg should be used, unless it can be substantiated that a greater amount is acceptable, based on the characteristics of the failure modes associated with the specific area of the transmission or gearbox under evaluation. In addition, no more than 20 minutes should elapse between the introduction of the first particles of ferromagnetic material and the generation of the caution/warning signal by the *chip detection system*. The applicant should consider particles with characteristics (shapes, sizes, densities and magnetic properties) representative of the potential types of damage or wear associated with the failure modes of the areas of the gearbox being tested. In addition, it should be ensured that the *chip detection system* performs its intended function under the range of expected operating conditions. Therefore, the applicant should take into consideration, by means of design analysis and/or dedicated testing, any aspects of the *chip detection system* and the gearbox~~es and transmissions~~ in which it is installed, that could affect the effectiveness of the system. These aspects should include the:

— attitude of the rotorcraft,

— temperature and viscosity of the oil,

— exact location from which the ferromagnetic particles are released, and the vicinity of any potential retention features which could trap *oil debris* particles.

(3) Means used for the demonstration of effectiveness. As an initial step, a preliminary design assessment should be performed. This evaluation should address all the areas of ~~the transmission or~~ each affected gearbox, or gearbox module, from which ferromagnetic particles could be released and the expected paths by which the particles will reach the chip detectors. The assessment should identify those design features that might impede particles from reaching a ~~chip~~ detector. In general, the areas of the ~~transmission or~~ gearbox to be considered for this evaluation should include those o~~nf~~ the main and/or tail rotor drive ~~path~~ train (or those which could affect the correct transmission of torque to the~~ose~~ main or tail rotors), including the contact locations of the bearings, gears and shafts that are internal to the ~~transmission or~~ gearbox.

The outcome of the preliminary design assessment should be used to determine the need for

testing of each relevant area of ~~rotor drive system transmissions and~~ each affected gearbox~~es~~. This could take into consideration that, in cases where a location can be justified to provide a conservative result relative to other locations, the number of areas tested could be optimised. The preliminary design assessment should also establish those areas for which sufficient information exists, based on ~~the~~ any available data from representative tests ~~and~~ or in-service experience from previous designs.

Based on the conclusions of the preliminary design assessment, the *effectiveness* of a *chip detection system* should be established by a combination of the following:

(a) A full-scale certification test of the ~~transmission or~~ gearbox by artificially introducing particles of ferromagnetic material, as described in point (2) of AMC 29.1337 . This test should be run in a series of phases, with measured amounts of ferromagnetic material to establish the quantity of material and the time needed to generate the caution/warning signal specified by point (a)(23) of CS 29.1305 for each ~~relevant~~ affected area of the ~~transmission or~~ gearbox. This compliance method should be used for those areas of ~~transmissions or~~ gearboxes for which the *effectiveness* cannot be confidently established by a detailed design assessment as described in (b) below.

In addition

— The test should be performed in a fully representative gearbox, including its lubrication system. For gearboxes with pressurised lubrication, some external elements of the lubrication system, which can be justified to have no impact on the results, may be replaced by test equipment.

— The full-scale certification test should be performed at a fixed attitude, rotational speed and lubricating oil temperature corresponding to those in which the gearbox is expected to spend the most time while in operation. The torque transmitted by the gearbox is not considered a relevant parameter for this test.

— The measured amount of ferromagnetic material should be introduced while the gearbox is rotating in stabilised conditions, wherever possible. Each introduction should be performed in a way that represents as closely as possible the expected behaviour of particles produced by the damage or wear mechanism.

— Each area of a gearbox identified for ~~testing~~ investigation should be the subject of a dedicated test phase, unless it can be justified that testing more than one area at the same time will still render ~~representative~~ valid results for each area.

— The test procedure should ensure that there is no contamination between the test phases. This will often require disassembly and detail cleaning of the gearbox being tested after each test phase.

(b) Detailed design analyses, combined with test data, supporting the performance of the ~~relevant~~ affected chip detect~~or~~sion systems in their local environments. This evaluation should be used to demonstrate that adequate design provisions are in place to ensure that the ferromagnetic particles released, as a result of damage or ~~excessive~~ *aggressive wear* in the ~~relevant~~ associated locations, will reach at least one ~~chip~~ detector. Test data should be available to ~~show~~ demonstrate that, based upon the performance of the relevant *chip detect~~or~~sion systems* in representative environments, the caution/warning signal specified

by point (23~~v~~) of CS 29~~7~~.1305 will be generated. When evaluating the available test data, the applicant should consider ~~that~~ whether, depending on the ~~area~~ location within ~~of~~ the ~~transmissions or~~ gearbox~~es~~ where the particles originate, additional test points may be needed, depending on the design of the *chip detect~~or~~sion systems* and the areas around them. In general~~, if questionable features exist that may trap particles or impede their progress, representative test data or in-service experience substantiating the impact of those details should be available to support the evaluation.~~ If features have been identified that may trap particles or impede their progress, representative test data or in-service experience demonstrating the impact of these features on the *chip detection system effectiveness* should be reported.

Supporting test data may be obtained from representative full-scale tests, previous similar designs and/or components or sub-assembly tests, as appropriate.

| **Commentor:** | UK CAA |
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**Page No:** 14 - 16

**Paragraph No:** AMC 29.1337 Powerplant Instruments (2) and (3)

**Comment:**
AMC 29.1337 currently describes performing a “preliminary design assessment” after performing tests to demonstrate the effectiveness of detectors. If the “preliminary design assessment” will be performed in advance of the ODM system effectiveness tests, then it may be more intuitive to exchange the locations of paragraphs (2) and (3) of AMC 29.1337 as currently proposed in the NPA.

**Justification:**
Ease of reading and understanding.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 15

**Paragraph No:** AMC 29.1337 (3) Powerplant Instruments

**Comment:**
The paragraph states “*The assessment should identify those design features that might impede particles from reaching a chip detector*”. The objective for this specific requirement activity is not clear.

**Justification:**
It is not clear whether the identified design features need to be eliminated or whether the chip detectors need to be relocated so that the features don't have an impact, or whether there needs to be a more in-depth analysis to establish how the features impact the efficiency of the chip detection system. Without a clear requirement for the activity there is a concern that a burden could be created

on the industry without any material safety benefit.

**Proposed Text:**
As required taking into account the above comment.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 16 and 18

**Paragraph No:** AMC 29.1337 (3)(b) and AMC 27.1337 (3) Powerplant Instruments

**Comment:**
It is recommended that the term “excessive wear” is replaced with “aggressive wear” throughout the amendment text.

We also recommend replacing “Test data should be available to show that …” with “Test data should demonstrate that …”

**Justification:**
"Wear" has a number of meanings the damage mechanisms arising from motion of two contacting surfaces in respect of each other and the damage caused by these mechanisms. If a reader interprets it as the damage caused, then there is an issue. It would be expected that the chip detection system would identify active wear mechanisms before excessive wear damage has occurred. Recommend that EASA makes it clear to the reader that "wear" is a damage mechanism and "excessive" is replaced by "aggressive".
Additionally, the term “aggressive wear” is defined with in the GM or AMC text.

**Proposed Text:**
As required taking into account the above comment.

Recommend deletion of "area of the transmissions or gearboxes where the particles originate" and replace with "origin of the particles".

In AMC 29.1337 (3)(b) suggest delete reference to "point (v) of CS 27.1305" and replace with "point (23) of CS 29.1305".

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 16 and 19

**Paragraph No:** AMC 29.1337 (3)(b) and AMC 27.1337 (3) Powerplant instruments

**Comment:**
We believe the statement “In general, if questionable features exist that may trap particles or impede their progress, representative test data or in-service experience substantiating the impact of those details should be available to support the evaluation.” is unclear.

**Justification:**
The text could be phrased more positively.

**Proposed Text:**
Recommend the following amendment:
"If features have been identified that may trap particles or impede their progress, representative test data or in-service experience demonstrating the impact of these feature on the chip detection system efficiency should be reported.”

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 16 and 19

**Paragraph No:** GM 29.1337 (1)(a) and GM 27.1337 (1)(a) Powerplant instruments

**Comment:**
We don't believe the guidance given in this paragraph is relevant to chip detectors located in areas of the gearbox above the sump.

**Justification:**
If chip detection system only has chip detectors above the sump and the oil flow is effectively directed to them we question whether it matters if the sump is flat.

**Proposed Text:**
Recommend some qualification text concerning location of the detectors is added.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 19

**Paragraph No:** GM 27.1337 (1)(a) Powerplant instruments

**Comment:**
Gearboxes are a subset of transmissions. Therefore, the NPA should state either "transmission" or "gearboxes". However, only gearboxes have an oil system, which is necessary for a chip detection system to function, in which case "gearboxes" should be stated.

**Justification:**
Only gearboxes have an oil system, which is necessary for a chip detection system to function.

**Proposed Text:**

(a) Flat oil sumps can significantly limit the capability of particles coming from different locations in the ~~transmission or~~ gearbox to move and reach a chip detector.

| **Commentor:** | UK CAA |
|---|---|

**Page No:** 19

**Paragraph No:** GM 27.1337 (1)(a), *Note* Powerplant instruments

**Comment:**
We suggest the note is amended: "point (3)(a) of AMC 29.1337 " is deleted and replaced with "point (3) of AMC 27.1337 ".