



European Union Aviation Safety Agency
Comment-Response Document (CRD) 2021-01

RELATED NPA: 2021-01 — RMT.0725 (SUBTASK 1)
17.12.2021

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1. Summary of the outcome of the consultation

Seventy-four comments were received from 14 stakeholders. Table 1 shows the number of comments received per commenter:

COMMENTERS	# OF COMMENTS
Airbus Helicopters	2
Agência Nacional de Aviação Civil (ANAC) ¹	2
Aircraft Owner and Pilot Association (AOPA) Sweden	1
Civil Aviation Authority (CAA) the Netherlands	1
Direction générale de l'aviation civile (DGAC) ² France	1
Eaton Sensing & Controls	6
General Aviation Manufacturers Association (GAMA)	5
Luftfahrt Bundesamt (LBA) ³	1
Norsk Helikopteransattes Forbund (NHF) ⁴ Technical Committee	3
Rolls-Royce Holdings plc	5
Sikorsky Aircraft	7
Socausud	3
Swedish Transport Agency (Transportstyrelsen)	1
CAA United Kingdom (UK)	36
Total	74

Table 1

Table 2 shows the number of comments per topic:

NPA 2021-01 SEGMENTS	# OF COMMENTS
General comments and other sections	18
Executive summary	1
2.1 Why we need to amend the rules — issue/rationale	3
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CS 29.1337 'Powerplant Instruments'	5
AMC No 1 29.917 'Rotor drive system design'	1
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AMC 29.1337 'Powerplant Instruments'	17
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CS 27.1337 'Powerplant Instruments'	2
CS-27 BOOK 1 — Appendix C — Criteria for Category A	2
GM 27.1337 'Powerplant Instruments'	4
4.5 What are the impacts	3
Total	74

Table 2

¹ 'National Civil Aviation Agency' (of Brazil) in English.

² 'Directorate General for Civil Aviation' or 'Civil Aviation Authority' in English.

³ 'Federal Aviation Office' or 'National Civil Aviation Authority' (of Germany) in English.

⁴ 'Norwegian Helicopter Employees' Association' in English.

Two fifths of the comments came from industry and the rest from the national competent authorities (NCAs). Apart from general comments, industry and NCAs mainly commented on the proposed acceptable means of compliance (AMC), as shown in Table 3:

# OF COMMENTS	Industry	NCAs	Others	Total
General comments and other sections	1	16	1	18
Executive summary	0	1	0	1
2.1 Why we need to amend the rules — issue/rationale	0	3	0	3
2.2 What we want to achieve — objectives	1	0	0	1
2.3 How we want to achieve it — overview of the proposals	1	0	0	1
2.4 What are the expected benefits and drawbacks of the proposals	1	0	0	1
CS 29.1337 ‘Powerplant Instruments’	2	3	0	5
AMC No 1 29.917 ‘Rotor drive system design’	0	0	1	1
AMC No 2 29.917 ‘Rotor drive system design’	7	3	1	11
AMC 29.1337 ‘Powerplant Instruments’	9	7	1	17
GM 29.1337 ‘Powerplant Instruments’	2	2	0	4
CS 27.1337	1	1	0	2
CS-27 BOOK 1 — Appendix C — Criteria for Category A	0	2	0	2
GM 27.1337 ‘Powerplant Instruments’	0	4	0	4
4.5 What are the impacts	3	0		3
Total	28	42	4	74

Table 3

A quarter of the comments received were not accepted, more than forty per cent were noted, and the remaining third were accepted or partially accepted, as shown in Table 4:

	ACCEPTED	PARTIALLY ACCEPTED	NOTED	NOT ACCEPTED	Total
# of comments	9	15	32	18	74
percentage	12 %	20 %	43 %	25 %	100 %

Table 4

Nineteen comments (a quarter of the total number of comments) affect the proposed regulatory text.

The individual comments and the responses to them are contained in Chapter 2 of this Comment-Response Document (CRD) 2021-01.

Section 2.4 of the Explanatory Note to Decision 2021/016/R includes a summary of the comments received and of the most significant changes to the text proposed in the related [NPA 2021-01](#).

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.

(General Comments)

-

comment	1	comment by: <i>DGAC France</i>
	Please note that DGAC France has no specific comments on this NPA.	
response	Noted	
comment	2	comment by: <i>Swedish Transport Agency, Civil Aviation Department (Transportstyrelsen, Luftfartsavdelningen)</i>
	Thank you for the opportunity to comment on NPA 2021-01, Rotocraft chip detection systems. Please be advised that there are no comments from the Swedish Transport Agency.	
response	Noted	
comment	8	comment by: <i>AOPA Sweden</i>
	AOPA Sweden	
	In general AOPA Sweden is in favour of the system with chips in the rotocraft engine to detect corrosion. As always, our concern is the costs and we suspect that the engines will be more expensive. Hence, a system has to be approved that allowe manufacturers to have fewer and maybe more simple chips in order to have the prices redused for smaller helicopters, oftenly used in general aviation.	
	Fredrik Brandel	
	Member of the board	



response	<p>AOPA Sweden</p> <hr/> <p>Noted</p>
comment	<p>10 comment by: LBA</p> <p>LBA has no comments</p>
response	<p>Noted</p>
comment	<p>28 comment by: UK CAA</p> <p>General Comment</p> <p>Comment:</p> <p>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. Spectrometric Oil analysis Programme).</p> <p>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.</p> <p>Justification:</p> <p>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.</p> <p>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.</p> <p>Proposed Text:</p> <p>See miscellaneous proposed changes in later UK CAA comments.</p>
response	<p>Noted</p> <p>The comment lies outside the scope of this rulemaking task (RMT).0725. The related Terms of Reference (ToR) is clearly about chip detectors, and the requirement to be equipped with a chip detector is not being changed.</p>

comment	<p data-bbox="368 235 416 271">29</p> <p data-bbox="1126 235 1388 271" style="text-align: right;">comment by: UK CAA</p> <p data-bbox="368 315 608 344">General Comment</p> <p data-bbox="368 371 512 400">Comment:</p> <p data-bbox="368 427 1388 539">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”.</p> <p data-bbox="368 566 544 595">Justification:</p> <p data-bbox="368 622 1388 779">“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.</p> <p data-bbox="368 806 568 835">Proposed Text:</p> <p data-bbox="368 862 1158 891">See miscellaneous proposed changes in later UK CAA comments.</p>
response	<p data-bbox="368 954 459 983">Noted</p> <p data-bbox="368 1010 927 1039">Please refer to the response to Comment°28.</p>
comment	<p data-bbox="368 1122 416 1158">30</p> <p data-bbox="1126 1122 1388 1158" style="text-align: right;">comment by: UK CAA</p> <p data-bbox="368 1202 608 1232">General Comment</p> <p data-bbox="368 1258 512 1288">Comment:</p> <p data-bbox="368 1314 1388 1426"><u>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.</u></p> <p data-bbox="368 1453 544 1482">Justification:</p> <p data-bbox="368 1509 1388 1621">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.</p> <p data-bbox="368 1648 568 1677">Proposed Text:</p> <p data-bbox="368 1704 1158 1733">See miscellaneous proposed changes in later UK CAA comments.</p>
response	<p data-bbox="368 1805 459 1834">Noted</p> <p data-bbox="368 1861 1388 1935">EASA used the LN-OJF accident as a reference to help it determine an appropriate level of performance. However, please note that this level of performance should be</p>

considered in combination with the design assessment and other applicable requirements, such as CS 29.571.

comment

32

comment by: UK CAA

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.

response

Noted

The scope of this RMT.0725 includes ‘chip detection systems’. The related [NPA 2021-01](#) uses the term ‘ferromagnetic particles’ because these are the type of particles that the chip detectors should detect, based on the existing requirements.

RMT.0725 does not relax the requirement to have a chip detector with an electrical indication capability; rather, it addresses the performance of chip detectors. This does not prevent applicants from proposing more advanced particle detection systems.

comment

33

comment by: UK CAA

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:



1. 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.
2. b. *Chip Detection System*: Any means of detecting and/or monitoring ferromagnetic particles in an oil system (pressurised or unpressurised “splash lubricated”) that meets the requirements of CS 2X.1337(e).
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.

response

Noted

Please refer to the response to Comment 49.

comment

35

comment by: 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



	<p>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”.</p> <p>Justification:</p> <p>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”.</p> <p>Proposed Text:</p> <p>See miscellaneous proposed changes in later UK CAA comments.</p>
response	<p>Noted</p> <p>EASA does not change the text, wherever possible, to avoid confusion as applicants are used to certain terms.</p>
comment	<p>36 comment by: UK CAA</p> <p>General Comment</p> <p>Comment:</p> <p>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”.</p> <p>Justification:</p> <p>29.1337(e) and 29.1305 should utilise consistent terminology.</p> <p>Proposed Text:</p> <p>See miscellaneous proposed changes in later UK CAA comments.</p>
response	<p>Noted</p> <p>Please refer to the response to Comment 47.</p>
comment	<p>37 comment by: UK CAA</p> <p>General Comment</p> <p>Comment:</p> <p>The NPA only applies the method of demonstration of the performance of ODM systems to systems which are both identified as compensating provisions for</p>

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.

response

Noted

EASA introduces some changes in response to some of the other comments submitted by the UK CAA. In addition, [NPA 2021-01](#) and the related Decision 2021/xxx/R do not change the scope of CS 29.1337(e), which is to monitor the presence of ferromagnetic particles by electrical chip detectors with indication capability.

comment

38

comment by: 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.



	<p>Justification:</p> <p>Testing prescribed should achieve statistically significant results.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p>
response	<p>Not accepted</p> <p>AMC 29.1337 ensures that the size and number of particles are appropriate for the expected location of the damage or wear. However, the applicant should address specific failure modes, such as those mentioned in the comment, through CS 29.917(b).</p>
comment	<p>39 comment by: UK CAA</p> <p>General Comment</p> <p>Comment:</p> <p>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.</p> <p>Justification:</p> <p>Text should be consistent with defining a method of compliance.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p>
response	<p>Not accepted</p> <p>This is an introductory statement that repeats the CS requirement.</p>
comment	<p>40 comment by: UK CAA</p> <p>General Comment</p> <p>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.</p> <p>Justification: Consistency</p>
response	<p>Noted</p>

comment	<p>62 comment by: UK CAA</p> <p>Dear EASA, please note that some of the comments that follow contain proposed text changes which are colour highlighted to show CAA proposed changes. EASA changes to the text that were highlighted in blue in the NPA are also included. However, unfortunately some of the formatting has been lost or only partially transposed when entering on to the CRT. Numbered paragraphs have also been affected in some places.</p> <p>We have therefore forwarded a word copy to RPS@EASA to pass onto the EASA Project Manager for ease of reference.</p> <p>Please accept our apologies for any inconvenience caused.</p>
response	<p>Noted</p>
comment	<p>70 comment by: Rolls-Royce plc</p> <p>Rolls-Royce also requests that EASA provide specific language to indicate if this rulemaking is applicable to gas-turbine engine gearboxes.</p>
response	<p>Noted</p> <p>RMT.0725 addresses only changes to CS-27 and CS-29.</p>
comment	<p>72 comment by: Civil Aviation Authority the Netherlands</p> <p>No comments on this NPA.</p>
response	<p>Noted</p>

Executive Summary	p. 1
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comment	<p>41 comment by: UK CAA</p> <p>Page No: 1</p> <p>Paragraph No: N/A</p> <p>Comment:</p>
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response

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.

Not accepted

The proposal is outside the scope of RMT.0725 (please refer to [ToR RMT.0725](#)).

However, the proposed changes do not prevent industry from developing more advanced means for monitoring degradation and for particle detection.

2.1. Why we need to amend the rules — issue/rationale

p. 5-6

comment

42

comment by: 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.

response

Not accepted

The objective of the comment is unclear in the context of the referenced paragraph.

comment

43

comment by: UK CAA

Page No: 5**Paragraph No:** 2nd paragraph

	<p>Comment: The final sentence of the 2nd paragraph states: “<i>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</i>”. We believe this is factually incorrect.</p> <p>Justification:</p> <p>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.</p> <p>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.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p>
response	<p>Noted</p> <p>In the context of RMT.0725, chip detection systems can only be considered reliable once their performance and effectiveness are proven (level of performance).</p>
comment	<p>44 comment by: UK CAA</p> <p>Page No: 5</p> <p>Paragraph No: 6th paragraph and throughout</p> <p>Comment:</p> <p>We recommend the term “excessive wear” should be replaced with “aggressive wear” throughout the amendment text.</p> <p>Justification:</p> <p>"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.</p> <p>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.</p> <p>Proposed Text:</p>

response	As required taking into account the above comment.
	<p>Not accepted</p> <p>The term ‘excessive wear’ is already used in the requirement, so industry is familiar with it. No benefit is gained by changing it to ‘aggressive wear’.</p>

2.2. What we want to achieve — objectives

p. 6

comment	<p>25 comment by: <i>Eaton Sensing</i></p> <p>Eaton is in agreement with 60 years of experience designing Chip Detection Systems for helicopter & all aircraft types, the most reliable and effective Chip Detection system occurs when the drive system design is a holistic approach. That is to say assuring proper placement of Chip Detection sensors within critical areas the drive system and oil flow paths to efficiently deliver the chips to the sensor for indication and method for retention and inspection.</p>
response	<p>Noted</p> <p>EASA thanks you for your comment.</p>

2.3. How we want to achieve it — overview of the proposals

p. 7-8

comment	<p>26 comment by: <i>Eaton Sensing</i></p> <p>Confirming the subject NPA addresses Subtask 1: (new designs), can EASA confirm if/when Subtask 2: (existing designs) will be addressed?</p>
response	<p>Noted</p> <p>NPA 2021-01 addresses Subtask 1 of RMT.0725.</p> <p>When Subtask 1 is completed, EASA will assess the need to address existing designs under Subtask 2.</p>



2.4. What are the expected benefits and drawbacks of the proposals

p. 8

comment

9

comment by: Sikorsky Aircraft

2.4: To fully test each mode with a compensating provision would be extensive rather than "slight". We do not concur with the characterization of the impact on certification costs as slight.

response

Noted

The objective of the requirement is not to test every single 'mode', but to verify the most severe modes and their locations. The understanding of EASA and of Rulemaking Group (RMG) RMT.0725 is that one single test article that may have been used for other certification testing is sufficient.

CS 29.1337 Powerplant Instruments

p. 9

comment

19

comment by: Airbus Helicopters

Comment: It seems that there is an inconsistency between CS29.1337 and related AC-29-2C.1337A(a)(4) content.

Page 9, the proposed text within the NPA is as follow *CS29.1337 (e)(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) are functioning correctly.*

AC-29-2C.1337A(a)(4) content is as follow *(4) Provide a test system to allow the crew to check, in flight, the function of each detector and wiring. The test circuit should test, at least, as much of the circuitry as reasonably possible. Where detectors are used that have a test feature in the form of an extra pin, all of the circuit, exclusive of the detector may be tested. Some chip detectors have a fuzz burner capability to eliminate nuisance indication of non-relevant conducting materials that result from oil contamination and very small wear particles.*

AC is reduced to circuit continuity check and doesn't require to check also the signal.

Further clarification should be provided regarding applicability of AC-29-2C.1337A(a)(4) content, as an acceptable means of compliance as mentioned in EASA CS227 book 2; or the NPA must be (e) (2) to remove the "signal" notion or to clearly defined what is intended with the term "signal".

Suggested resolution: *CS29.1337 (e)(2) Be provided with a means to allow crew members to check or to be informed of, in flight, whether the **electrical circuits** of the chip detector(s) are functioning correctly.*



response	Accepted The term 'signals' was removed from the proposed text.
comment	<p>45 comment by: UK CAA</p> <p>Page No: 9 and 17</p> <p>Paragraph No: CS 29.1337 (e) and CS 27.1337 (e)</p> <p>Comment:</p> <p>The proposed requirement uses the term "effectively". We believe terms like "effectively" should not be used in regulations or certification specifications.</p> <p>Justification:</p> <p>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.</p> <p>Proposed Text:</p> <p>Recommend EASA to either delete the term "effectively" or define what is considered to be effective.</p> <p>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.</p>
response	<p>Not accepted</p> <p>The main objective of AMC is to define the means for demonstrating an acceptable level of effectiveness of the chip detection system.</p> <p>AMC defines what is understood by 'effectiveness' and provides a measure of what is considered an effective chip detection system.</p>
comment	<p>46 comment by: UK CAA</p> <p>Page No: 9</p> <p>Paragraph No: CS 29.1337 Powerplant Instruments</p> <p>Comment:</p> <p>Miscellaneous changes are proposed to the NPA text as detailed below</p> <ul style="list-style-type: none"> — 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.~~

response

Not accepted

Changes to the existing text were limited as applicants are already familiar with the requirements. EASA sees no added value in the modifications proposed.

comment

47

comment by: 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

[...]



response	<p>(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 ...</p> <p>Accepted</p>
comment	<p>66 comment by: <i>Rolls-Royce plc</i></p> <p>As written the text "electrical circuits and signals of the chip detector(s) are functioning correctly" cannot be satisfied, as correct function of the electrical circuits and signals requires metallic debris to be collected in order to induce a signal.</p> <p>Proposed solution:</p> <p>(2) Be provided with a means to allow crew members to check or to be informed of, in flight, whether the electrical circuits and any associated powerplant indications of the chip detector(s) are functioning.</p>
response	<p>Accepted</p> <p>The term 'signals' was removed from the proposed text.</p>

AMC No 1 to 29.917 Rotor drive system design p. 10-12

comment	<p>5 comment by: <i>NHF Technical committee</i></p> <p>Page 11</p> <p>5. <i>"Extremely remote lubrication failure: a lubrication failure where the likelihood of occurrence has been minimised, either by structural analysis in accordance with CS 29.571 or laboratory testing. Alternatively, in-service experience or other means can be used which indicate a level of reliability comparable with one failure per 10 million hours. Failure modes including failures of external pipes, fittings, coolers, or hoses, and any components that require periodic removal by maintainers, should not be considered as extremely remote lubrication failures"</i></p> <p><i>If you make a system with lots of pipes and connections and do not take into account that it can be screwed together incorrectly or in any way leakage may not be designed well enough for the intention.</i></p> <p><i>You need to take in account that there is a possibility that there is room for errors.</i></p>
response	<p>Noted</p>



[NPA 2021-01](#) does not propose to amend this text, it only proposes editorial changes.

AMC No 2 to 29.917 Rotor drive system design

p. 13

comment

3

comment by: *NHF Technical committee*

Page 13

"(2) *In order to be accepted as an appropriate compensating provision, the chip detection system must effectively indicate the presence of particles released due to degradation that could lead to the failure modes 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 for all the relevant hazardous and catastrophic failure modes should be substantiated by full-scale testing.*"

This is to vaugé, need to be more specific limits.

response

Not accepted

The text clearly specifies when a full-scale test should be used to demonstrate compliance, and that the effectiveness criteria that are defined in AMC 29.1337 may be used to substantiate chip detection as an acceptable compensating provision.

comment

11

comment by: *Sikorsky Aircraft*

(2): Compensating provisions are not always stand-alone, and chip detection may be identified, but may not be "primary". For example, if fatigue evaluation per 29.571 has been completed for a given mode, it becomes primary. The requirement should be applicable if it is the sole or primary compensating provision.

response

Not accepted

The notion of 'primary' compensating provision is not defined in the existing CS 29.917(b) or related AMC.

If EASA considers a chip detector a necessary compensating provision for hazardous or catastrophic failure conditions, the applicant should demonstrate through full-scale tests that this chip detector is effective in order to be considered an acceptable compensating provision.



comment	<p>20 comment by: <i>General Aviation Manufacturers Association</i></p> <p>There is no change to the rule for 29.917(b) associated with this change, thus what is the justification for this added guidance?</p> <p>In the absence of a change to the rule for a particular regulation what is rationale for increasing the burden required to comply to the rule by following the AMC.</p> <p>We recommend to remove AMC No 2 for 29.917 and just rely on the changes to 29.1337 and the AMC for 29.1337.</p>
response	<p>Not accepted</p> <p>EASA may change an AMC without changing the related certification specification (CS).</p> <p>In this case, there is a clear link between the need to demonstrate the effectiveness of chip detectors and their use as a compensating provision under CS 29.917(b).</p>
comment	<p>21 comment by: <i>General Aviation Manufacturers Association</i></p> <p>The added guidance in absence of a rule change could be overburdensome.</p> <p>If the previous recommendation is not taken, then in this case since there is no accompanying rule change it seems prudent to leave the added guidance more generic in nature and sufficient information is provided in the proposed rule change for 29.1337(e) and the associated accompanying AMC 29.1337 guidance.</p> <p>We suggest limiting the change to the AMC for 29.917 to something similar to what already exists for Vibration Health Monitoring, i.e. remove all added wording for AMC 2 and replace it with; "Where Chip Detection Systems are used as a compensating provision to meet point (b) of CS 29.917, the design and performance of the chip detection system should be approved by requesting compliance with point (e) of CS 29.1337".</p>
response	<p>Not accepted</p> <p>The scope of AMC3 29.917(b) goes beyond demonstrating compliance with CS 29.1337(e). While the applicant is generally required to demonstrate compliance with CS 29.1337(e), the additional considerations in AMC3 29.917(b) only apply to those systems that are identified as a compensating provision for hazardous and/or catastrophic failures.</p>

comment	<p>22 comment by: <i>General Aviation Manufacturers Association</i></p> <p>In paragraph (2) of the AMC it is stated that the chip detection effectiveness for all hazardous and catastrophic failure modes should be substantiated by full scale testing. This is likely cost prohibitive.</p> <p>Performing a test for each specific hazardous or catastrophic failure mode for which chip detection is a mitigating provision could result in an excessive number of tests to be performed. Instead a representative subset of worst case conditions should only be tested as is allowed for in the proposed AMC for 29.1337.</p> <p>We suggest the replacement of: "the effectiveness of the chip detection system for all the relevant hazardous and catastrophic failure modes should be substantiated by full-scale testing" with "the effectiveness of the chip detection system should be substantiated by full-scale testing. The testing should include a sufficient number of test points, including the worst case scenarios, to represent all hazardous and catastrophic failure modes".</p>
response	<p>Partially accepted</p> <p>'testing' was replaced by 'test evidence'.</p>
comment	<p>48 comment by: <i>UK CAA</i></p> <p>Page No: 13</p> <p>Paragraph No: AMC No 2 to 29.917, Rotor drive system design</p> <p>Comment:</p> <p>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.</p> <p>Justification:</p> <p>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.</p> <p>Additionally, there does not appear to be consideration of "human factors" such as the non-recognition of critical degradation after first chip detection.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p>
response	<p>Noted</p> <p>G-REDL accident: EASA has no information on how much ferromagnetic debris was produced before the accident.</p>

LN-OJF accident: EASA considered the data from the investigation of this accident when it defined the means to demonstrate the effectiveness of the chip detection system that is detailed in the AMC to 29.917 and 29.1337.

Furthermore, RMT.0725 on chip detection systems is just one out of a series of measures that EASA is taking, following the accident, to improve the level of safety.

comment

49

comment by: 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 (e) 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 ~~modes~~ 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 ~~modes~~ 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.

response

Partially accepted

A part of the text was adapted accordingly.

comment

50

comment by: 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.

response

Not accepted

Please refer to the response to Comment 45.

comment

63

comment by: SOCAUSUD

The detection efficiency of a chip detection system of a helicopter gearbox (Main Gearbox in particular) is strongly determined by the design of the lubrication system, of the chip detector installation and of the chip detectors themselves.



	<p>In my experience I found several time that the good design principles of the above areas have been ignored resulting in poor and/or unpredictable chip detection system poor efficiency.</p> <p>Therefore, the AMC of this rule should provide suggestions and guidelines toward the adoption of pest practice by expliciting these and/or making reference to industry standard, public domain documents, such as AIR 1828 (Guide to Engine Lubrication System Monitoring) or equivalent document considered suitable by EASA.</p>
response	<p>Not accepted</p> <p>The AMC stresses the importance of a holistic design philosophy when ensuring an adequate chip detection effectiveness. In addition, the main objective of RTM.0725 is to ensure that the performance of the chip detection system is adequately demonstrated; the design means that are used to achieve this objective are considered less important.</p>
comment	<p>64 comment by: SOCAUSUD</p> <p>The 60 mg / 20 minutes rule seems fairly realistic, but is also very generic.</p> <p>For example there is no mention to the particle size distribution and to the minimum particle size to be detected.</p> <p>I think that the AMC of this rule should provide more detail about the quantitative substantiation requirements.</p>
response	<p>Not accepted</p> <p>Flexibility is needed to allow applicants to define particle size and distribution according to the damage mode identified. AMC 27.1337 and AMC 29.1337 state that particle characteristics should be representative of the damage or excessive wear in the areas being tested.</p>
comment	<p>65 comment by: SOCAUSUD</p> <p>in this proposed rule it is stated "chip detection system used as a compensating provision for hazardous or catastrophic failures", therefore credit is given to the chip detection system to detect with useful time anticipation and reliability such type of failures.</p> <p>However, no requirement is given to the minimum reliability of the chip detector to be used for this purpose and the way to demonstrate it.</p>

response

Noted

AMC3 29.917(b) states that compliance with CS 29.1337 should be demonstrated through a test for the failure modes that the chip detection system is intended to mitigate, to consider a chip detection system an appropriate compensating provision. AMC1 29.1337(e) defines the performance criteria that the chip detection system should fulfil to achieve that objective.

Additional text was introduced into GM1 27.1337(e) and GM1 29.1337(e) to address the aspect of reliability of the chip detection system.

AMC 29.1337 Powerplant Instruments

p. 14-16

comment

4

comment by: *NHF Technical committee*

Page 14

"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

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"

60mg? The limits for the EC225 is far more strict for sampling of particles for analysis. 60mg does not take into account type (shape and material) of chip, who is really important to know regarding type of degradation of parts.



response

Noted

The EC225 MGB removal criteria address particles that are accumulated on the chip detectors; maintenance is expected to be carried out after particles that amount to significantly less than 60 mg have been collected. However, '60 mg', as defined in the AMC, refers to particles that are released in the MGB, which demonstrates that this limited amount of particles generates the chip detector caution/warning signal. The applicant should consider particle characteristics, such as shape and material, following the chip detector caution/warning signal. This should be addressed in the instructions for continued airworthiness (ICA), together with the relationship of those particle characteristics to degradation of parts and the actions to be taken. All that is now addressed under AMC1 27.1337(e) and AMC1 29.1337(e).

comment

12

comment by: Sikorsky Aircraft

(1) The system includes the maintenance tasks in addition to the hardware itself. Besides operational indication, there may be scheduled inspections that result in findings of lesser quantity of chips. Establishing criteria, and interpretation of particles is a bona fide part of the system to determine fault. An additional step to ensure the interval, or conditional task, should be included in the Appendix A instructions for continued airworthiness.

response

Noted

The system is required to provide an indication to the cockpit if ferromagnetic debris is present in rotor drive system transmissions or gearboxes. Therefore, AMC 29.1337 focuses on the system's effectiveness to produce this indication.

Additional guidance was introduced into AMC1 27.1337(e) and AMC1 29.1337(e) to address maintenance and ICA considerations.

comment

13

comment by: Sikorsky Aircraft

(2): 60 mg of slivers is different than 60 mg of flakes. And chip detectors come in different sizes, with different size gaps. The greater amount, or lesser amount, should take into consideration expected characteristic chips, and from which source.

response

Noted

60 mg of ferromagnetic particles is the same amount of ferromagnetic debris regardless of the kind of those particles. It is expected that the type certificate holder (TCH) will optimise the size gap of the chip detectors in accordance with the characteristics of the particles that are expected to be collected. In addition, the TCH may substantiate that a greater amount of particles may be used considering the



characteristics of the failure modes monitored, which may include the shape characteristics of the particles released.

comment 14 comment by: Sikorsky Aircraft

(2) **Demonstration of effectiveness:** 20 minutes is arbitrary. The time to indicate should be evaluated to the rate of material breakdown. In some systems, it may be acceptable for chips to settle by gravity after shutdown, and be detected upon system startup next flight.

response Partially accepted

The 20-min measure ensures that adequate design provisions are in place to drive any released particles to the chip detectors. However, the text was amended to allow for a greater duration to be considered if the applicant demonstrates that a specific design feature of the chip detection system consistently generates a chip detection signal in more than 20 min.

comment 23 comment by: General Aviation Manufacturers Association

The organization of subsections (1), (2), and (3) is confusing as there is some overlap and what could be construed as some conflicting information between the sections. For example, the 3rd paragraph of Section (2) contains specific test requirements which seem to fit more logically in Section (3). Another example, the difference between the variable aspects listed in the fourth paragraph of (2) and the specific requirements in the second sub bullet in (3)(a) is unclear.

We suggest the reorganization of subsections (1), (2), and (3) to eliminate overlap and remove conflicts.

response Partially accepted

The structure of the AMC was modified accordingly.

comment 24 comment by: General Aviation Manufacturers Association

The value of 60 mg is too restrictive in our experience. It is GAMA's position that 200 mg is more representative of and sufficient to detect typical spalling failures of bearings and gear teeth prior to loss of function.

The amount of chips to be ingested in testing to demonstrate the effectiveness of a chip detection system should not be driven by any one particular failure mode because not all failure modes will produce the same quantity of debris and it should not be expected for the chip detection system to capture all debris generated.



response	<p>We suggest the change of 60 mg to the volume and size of debris commensurate with the failure mode being detected. For example, 200 mg has been shown to be sufficient to detect typical bearing and gear tooth spalling or pitting failures well in advance of loss of function. However, certain types of sudden catastrophic failure modes involving the structural integrity of the integral component have shown the need for more stringent requirements.</p> <p>Partially accepted</p> <p>The 60 mg are now presented as an alternative to justifying the amount of particles that are used for this demonstration. The applicant may choose to use the 60 mg when it is not possible to adequately substantiate the amount of particles that are representative of each area of the gearbox under assessment.</p> <p>Therefore, the applicant may even use an amount of 200 mg as long as it can be justified.</p>
comment	<p>27 comment by: <i>Eaton Sensing</i></p> <p>the effectiveness of the chip detection system is dependent upon:</p> <ul style="list-style-type: none"> — the design of the rotor drive system’s transmission or gearbox; — the design of the lubrication flow and transport efficiency of chips away from the generation points to sensor collection location (and prior to filters and other chip flow obstructions) — the location of the chip detector; and — the design of the chip detector.
response	<p>Partially accepted</p> <p>The text was amended accordingly.</p>
comment	<p>31 comment by: <i>Eaton Sensing</i></p> <p>60 mg of Chips in 20 minutes as an acceptable effectiveness of the Chip Detection System is a generalization that may require more definition. Are all Chips generated from one source? Multiple sources? Is the measurement of 60 mg the amount transported completely to the Chip Detection sensor? Is it independent of temperature, viscosity, air content, velocity (all factors fo Chip transport efficiency). So in a test situation, capture/indication values may vary. I.e.- if 60 mg of Chips are released and 30 mg are captured/indicated and the rest are found downstream of the sensor, that may be viewed as 50% capture/indication efficiency. But if 60 mg are released and only 30mg are transported to the sensor and indicated, that may be</p>

response

viewed as 100% capture/indication. The other 30mg are lost to other design inefficiencies other than the Chip Detection device.

Noted

The 60 mg of ferromagnetic particles should be used for each tested location. It is expected that the applicant will test each location in isolation to ensure the effectiveness of the chip detection system for each of them.

Using 60 mg of ferromagnetic particles in 20 min, at a fixed temperature and viscosity of the oil, as well as attitude of the rotorcraft and rotational speed, aims at demonstrating an overall good performance of the system. By obtaining a caution/warning signal from the chip detection system under such conditions, the applicant demonstrates that the system has an adequate level of effectiveness even if sources of variability were considered. A minimum capture/indication ratio does not need to be defined as for certain designs or specific areas of gearboxes, the amount of particles that will reach the chip detectors may be more limited, which may require more sensitive chip detectors.

comment

51 comment by: UK CAA

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.

response

Not accepted

The objective of AMC1 29.1337(e) is to demonstrate an overall adequate performance of the chip detection system. When this system is used as a compensating provision for a specific hazardous or catastrophic failure mode, AMC2 29.917(b) states that enhanced objectives for the demonstration of the chip



detection system effectiveness should replace those of AMC1 29.1337(e), where needed.

comment

52

comment by: 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.

response

Noted

When considering a specific failure mode to be mitigated by the chip detection system in accordance with AMC3 29.917(b), the applicant should demonstrate that the criteria for the demonstration of effectiveness of AMC1 29.1337(e) are adequate.

comment

53

comment by: UK CAA

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 **gearboxes 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 **of** the main and/or tail rotor drive **path train** (or those which could affect the correct transmission of torque to **these 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 gearboxes**. 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 detection 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



	<p>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 detection systems in representative environments, the caution/warning signal specified by point (234) of CS 297.1305 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 gearboxes where the particles originate, additional test points may be needed, depending on the design of the chip detection 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.</p> <p>Supporting test data may be obtained from representative full-scale tests, previous similar designs and/or components or sub-assembly tests, as appropriate.</p>
response	<p>Not accepted</p> <p>Please refer to the response to previous UK CAA comments that propose these changes in terminology.</p>
comment	<p>54 comment by: UK CAA</p> <p>Page No: 14 - 16</p> <p>Paragraph No: AMC 29.1337 Powerplant Instruments (2) and (3)</p> <p>Comment:</p> <p>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.</p> <p>Justification:</p> <p>Ease of reading and understanding.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p>



response	Accepted The structure of the AMC was modified as proposed.
comment	55 comment by: UK CAA Page No: 15 Paragraph No: AMC 29.1337 (3) Powerplant Instruments Comment: The paragraph states <i>“The assessment should identify those design features that might impede particles from reaching a chip detector”</i> . 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.
response	Partially accepted The objective of the preliminary design assessment is described in the subsequent paragraph. The AMC structure was changed to clarify the objective of the preliminary design assessment.
comment	56 comment by: 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 <i>“excessive wear”</i> is replaced with <i>“aggressive wear”</i> throughout the amendment text. We also recommend replacing <i>“Test data should be available to show that ...”</i> with <i>“Test data should demonstrate that ...”</i>



	<p>Justification:</p> <p>"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".</p> <p>Additionally, the term "aggressive wear" is defined within the GM or AMC text.</p> <p>Proposed Text:</p> <p>As required taking into account the above comment.</p> <p>Recommend deletion of "area of the transmissions or gearboxes where the particles originate" and replace with "origin of the particles".</p> <p>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".</p>
response	<p>Partially accepted</p> <p>The text of the AMC was improved accordingly.</p> <p>However, the term 'aggressive wear' was not retained.</p>
comment	<p>58 comment by: UK CAA</p> <p>Page No: 16 and 19</p> <p>Paragraph No: AMC 29.1337 (3)(b) and AMC 27.1337 (3) Powerplant instruments</p> <p>Comment:</p> <p>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.</p> <p>Justification:</p> <p>The text could be phrased more positively.</p> <p>Proposed Text:</p> <p>Recommend the following amendment:</p> <p>"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."</p>

response

Partially accepted

The text of the AMC was improved accordingly.

comment

67

comment by: *Rolls-Royce plc*

"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 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"

I think it would be beneficial to consider if the 60mg is a good hard requirement. I know that it say that the applicant should consider particle size but if the applicant needs to consider this does the AMC really have to prescribe a weight? If it is a small gearbox that may end up being a lot of material but if it is a large gearbox that may be a small amount of material. Generally in our capture efficiency testing we just list chip size and quantity so it will likely take bit of work to determine how 60mg compares. An even better if would be to show that the amount of material being introduced on the test is consistent with what would be expected during a failure.

Proposed solution:

"it is considered acceptable to show that a caution/warning signal is generated by the chip detection system following the release of ferromagnetic material from any relevant area of the transmission or gearbox. The amount (weight) and particle size of ferromagnetic material should be consistent with what would be expected during a failure and the volume of oil in the gearbox."

response

Partially accepted

The objective of the proposed text is met by presenting the 60 mg as an alternative amount of particles. That amount is a minimum acceptable standard to be used without in-depth investigation of failure modes at every critical location.

comment

68

comment by: *Rolls-Royce plc*

"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 20 minutes for a required detection time seems a bit over prescriptive. If the FMECA says that historically the failure mode has longer than 20 minutes to be detected then would this really be required. I would think that this would be especially true if we had to test the capture indication of the turbine sumps. Based on the current guidance the chips would be introduced from a port in the structure somewhere to assess whether the chips get stuck in any scavenge passages. The



chips would need to scavenge and get through the scavenge pump. Test experience has shown that it can take up to 13 minutes to indicate even when the chips were introduced into the gearbox where the mag plug was located. An even better if would be to say that the chips should be detected within the time needed to respond to the identified failure mode.

Proposed solution:

"The time lapse between introduction of the first particles of ferromagnetic material and the generation of the caution/warning signal by the chip detection system should allow sufficient time for the response to the identified failure mode"

response

Please refer to the response to Comment 14.

GM 29.1337 Powerplant Instruments

p. 16-17

comment

7

comment by: *ANAC*

Based on the fact that some performance issues on the chip detector systems are related with shortening due to water con cabling and coupling, a note might be useful on this GM

response

Partially accepted

Additional text was introduced into the AMC (previously guidance material (GM)) on electrical system reliability. However, the concern about water ingress is too specific for the objectives of the AMC.

comment

15

comment by: *Sikorsky Aircraft*

(1)(d): There should be a separate paragraph for non-pressure lubricated gearboxes, those sytems that do not have pumps may utilize a detector at the lowest point in the system.

response

Accepted

The proposed text was introduced into the AMC (previously GM).

comment

34

comment by: *Eaton Sensing*

All good points and agree fully the detailed importance of the equipment with respect to lubrication and Chip movement. The goal is to efficiently concentrate



	generated wear debris (Chips) as early as possible to the sensing device selected: Chip Detector.
response	Noted
comment	<p>59 comment by: UK CAA</p> <p>Page No: 16 and 19</p> <p>Paragraph No: GM 29.1337 (1)(a) and GM 27.1337 (1)(a) Powerplant instruments</p> <p>Comment:</p> <p>We don't believe the guidance given in this paragraph is relevant to chip detectors located in areas of the gearbox above the sump.</p> <p>Justification:</p> <p>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.</p> <p>Proposed Text:</p> <p>Recommend some qualification text concerning location of the detectors is added.</p>
response	<p>Accepted</p> <p>The text of the GM (now in an AMC) was modified accordingly.</p>

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comment	<p>18 comment by: Airbus Helicopters</p>
	<p>Comment: There is an inconsistency between CS29 and CS27 where the terms "or to be informed" has been added within CS29.1337 (e)(2) but not in CS27.1337 (e)(2).</p> <p>Page 9, the proposed text within the NPA is as follow <i>CS29.1337 (e)(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) are functioning correctly.</i></p> <p>When page 17, the proposed text within the NPA is as follow <i>CS27.1337 (e) (2) be provided with a means to allow crew members to check, in flight, whether the electrical circuits and signals of the chip detector(s) are functioning correctly.</i></p> <p>Suggested resolution:</p>

<p>response</p>	<p>CS27.1337 (e) (2) be provided with a means to allow crew members to check, <u>or to be informed of</u>, in flight, whether the electrical circuits and signals of the chip detector(s) are functioning correctly.</p> <p>Comment:</p> <p>Considering the AH comment on CS 29.1337 it will be necessary to align both CS27.1337 (e) (2 and CS29.1337 (e) (2) contents once a position will be defined.</p> <p>It shall be noticed that AC-27-1B.1337A(a) doesn't mention anything. The equivalent of AC-29-2C.1337A(a)(4) does not exist.</p> <p>Suggested resolution:</p> <p><i>CS27.1337 (e)(2) Be provided with a means to allow crew members to check or to be informed of, in flight, whether the electrical circuits of the chip detector(s) are functioning correctly.</i></p> <p>Accepted</p> <p>Please refer to the responses to similar comments on CS-29.</p>
<p>comment</p>	<p>45 comment by: UK CAA</p> <p>Page No: 9 and 17</p> <p>Paragraph No: CS 29.1337 (e) and CS 27.1337 (e)</p> <p>Comment:</p> <p>The proposed requirement uses the term “effectively”. We believe terms like “effectively” should not be used in regulations or certification specifications.</p> <p>Justification:</p> <p>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.</p> <p>Proposed Text:</p> <p>Recommend EASA to either delete the term "effectively" or define what is considered to be effective.</p> <p>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.</p> <p>response</p> <p>Not accepted</p> <p>Please refer to the responses to similar comments on CS-29.</p>



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comment

56

comment by: 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".

response

Partially accepted

Please refer to the responses to similar comments on CS-29.

comment

58

comment by: UK CAA

Page No: 16 and 19**Paragraph No:** AMC 29.1337 (3)(b) and AMC 27.1337 (3) Powerplant instruments**Comment:**

	<p>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.</p> <p>Justification:</p> <p>The text could be phrased more positively.</p> <p>Proposed Text:</p> <p>Recommend the following amendment:</p> <p>"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."</p>
response	<p>Partially accepted</p> <p>Please refer to the responses to similar comments on CS-29.</p>

GM 27.1337 Powerplant Instruments

p. 19

comment	<p>6 comment by: ANAC</p> <p>Based on the fact that some performance issues on the chip detector systems are related with shortening due to water con cabling and coupling, a note might be useful on this GM.</p>
response	<p>Partially accepted</p> <p>Please refer to the response to Comment 7.</p>
comment	<p>59 comment by: UK CAA</p> <p>Page No: 16 and 19</p> <p>Paragraph No: GM 29.1337 (1)(a) and GM 27.1337 (1)(a) Powerplant instruments</p> <p>Comment:</p> <p>We don't believe the guidance given in this paragraph is relevant to chip detectors located in areas of the gearbox above the sump.</p> <p>Justification:</p> <p>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.</p>



response	<p>Proposed Text:</p> <p>Recommend some qualification text concerning location of the detectors is added.</p> <p>Accepted</p> <p>The text of the GM (now in an AMC) was modified accordingly.</p>
comment	<p>60 comment by: UK CAA</p> <p>Page No: 19</p> <p>Paragraph No: GM 27.1337 (1)(a) Powerplant instruments</p> <p>Comment:</p> <p>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.</p> <p>Justification:</p> <p>Only gearboxes have an oil system, which is necessary for a chip detection system to function.</p> <p>Proposed Text:</p> <p>(a) Flat oil sumps can significantly limit the capability of particles coming from different locations in the transmission of gearbox to move and reach a chip detector.</p>
response	<p>Not accepted</p> <p>Please refer to the response to Comment°35.</p>
comment	<p>61 comment by: UK CAA</p> <p>Page No: 19</p> <p>Paragraph No: GM 27.1337 (1)(a), Note Powerplant instruments</p> <p>Comment:</p> <p>We suggest the note is amended: "point (3)(a) of AMC 29.1337 " is deleted and replaced with "point (3) of AMC 27.1337".</p>
response	<p>Accepted</p>



4.5. What are the impacts

p. 25-27

comment

16

comment by: Sikorsky Aircraft

4.5.4: Table 4: We disagree with this assessment. A test gearbox being consumed is by itself is costly, and moreso when adding up additional measurements and the facility configuration. Such a test will easily exceed one million U.S. dollars. The second option, involving a design assessment and test evidence, may be less expensive, but still involves hundreds of engineering hours.

response

Noted

Sikorsky's cost estimate is comparable to the estimate indicated in [NPA 2021-01](#). The economic impact is then established following standard EASA processes for the evaluation of the economic impact on entities.

comment

57

comment by: Eaton Sensing

When comparing the impacts of the proposed improvements, only Subtask-1 is considered. However impact on new aircraft yet to be launched is lower when compared to Subtask-2: existing fleets of aircraft with known reliability/safety deficiencies. Will Subtask-2 be considered in the near-term for action/completion?

response

Noted

EASA will develop a separate impact assessment (IA) for RMT.0725, Subtask 2.

comment

69

comment by: Rolls-Royce plc

The total estimated cost corresponds to EUR 1 300 000 for a CS-29 rotorcraft and EUR 500 000 for a CS-27 rotorcraft, as provided by a European rotorcraft TC holder with experience in this kind of test.

Rolls-Royce believes that estimated cost is low in particular for cases where the applicant is required to run multiple tests per AMC 29.1337(2).

Proposed solution:

Since this rulemaking does not specifically exclude gas-turbine engine gearboxes from this rulemaking activity Rolls-Royce recommends that EASA expand its cost survey to include gas-turbine engine manufacturers.



response

Not accepted

[NPA 2021-01](#) does not affect products whose certification basis is CS-E (Certification Specifications and Acceptable Means of Compliance for Engines).

