Certification Specifications
Acceptable Means of Compliance
and
Guidance Material
for
Large Rotorcraft

CS-29 Amendment 10 — Change Information

The European Union Aviation Safety Agency (EASA) issues amendments to certification specifications (CSs) as consolidated documents. These documents are used for establishing the certification basis for applications submitted after the date of entry into force of the applicable amendment.

Consequently, except for a note '[Amdt No: 29/10]' under the amended rule, the consolidated CS-29 Amendment 10 (Annex 2 to ED Decision 2021/016/R) does not highlight the changes introduced. To show the changes, this change information document was created, using the following format:

— deleted text is ~~struck through~~;

— new or amended text is highlighted in blue;

— an ellipsis '[…]' indicates that the rest of the text is unchanged;

Corrigendum

— new text is highlighted in yellow;

— deleted text is ~~struck through and highlighted in yellow~~.

Note to the reader

In amended, and in particular in existing (that is, unchanged) text, 'Agency' *is used interchangeably with* 'EASA'*. The interchangeable use of these two terms is more apparent in the consolidated versions. Therefore, please note that both terms refer to the* 'European Union Aviation Safety Agency (EASA)'.

PREAMBLE

CS-29 Amendment 10

Effective: ***See Decision 2021/016/R***

The following is a list of paragraphs affected by this amendment.

Subpart D	
CS 29.631	Amended (NPA 2021-02)
AMC1 29.631	Created (NPA 2021-02)
Subpart E	
AMC1 29.917	Amended (NPA 2021-01)
AMC2 29.917	Amended (NPA 2021-01)
AMC3 29.917	Amended (NPA 2021-01)
AMC1 29.927(c)	Amended (NPA 2021-01)
Subpart F	
CS 29.1305	Amended (NPA 2021-01)
CS 29.1337	Amended (NPA 2021-01)
AMC1 29.1337(e)	Created (NPA 2021-01)
GM1 29.1337(e)	Created (NPA 2021-01)

SUBPART D —~~–~~ DESIGN AND CONSTRUCTION

GENERAL

[…]

CS 29.631 Bird strike

(See AMC1 29.631)

The rotorcraft must be designed to ~~as~~ensure ~~capability of~~a continued safe flight and landing (for Category A) or a safe landing (for Category B) after a~~n impact~~ strike with a 1.0~~-~~kg (2.2-lb) bird~~,~~ when the velocity of the rotorcraft ~~(~~relative to the bird along the flight path of the rotorcraft~~)~~ is equal to V_{NE} or V_H 'True Airspeed' (TAS), ~~(~~whichever is ~~the~~ less~~er)~~, at altitudes up to 2 438 m (8 000 ft). The applicant must demonstrate c~~C~~ompliance ~~must be shown by~~through tests, or ~~by~~ analysis based on tests that are carried out on sufficiently representative structures of similar design.

[Amdt No: 29/10]

AMC1 29.631 Bird strike

This AMC supersedes AC 29.631 of Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C. The applicant should consider this AMC to demonstrate compliance with CS 29.631.

(a) To demonstrate the remaining capability of the rotorcraft after a single bird strike, the applicant should evaluate the following parts of the rotorcraft:

(1) the windshield directly in front of the occupants and its supporting frame, which should be capable of withstanding a bird strike without penetration; and

(2) other exposed structures, systems, and equipment, particularly flight control surfaces (including the main and tail rotors) and any exposed flight control system components.

(i) The applicant should make a final selection of the areas to be evaluated based on a comprehensive hazard analysis of the following:

(A) the damage to the structures, equipment, or systems that are exposed to the trajectory of the bird, based on conservative assumptions; and

(B) the criticalities of those exposed items and their capability to ensure a continued safe flight and landing (for Category A) or a safe landing (for Category B).

(ii) When performing the hazard analysis, the applicant should consider the following effects of a bird strike:

(A) direct effects to ensure the integrity of the structures and the functionality of the systems or equipment (also considering shock loads) that are critical for a continued safe flight and landing (for Category A) or a safe landing (for Category B), as applicable; and

(B) induced effects to examine the possible consequences of pieces ejected from the structures, systems, or equipment that are struck by a bird on other structures, systems, and equipment.

Note: the capability to withstand multiple bird strikes is only evaluated for engines as specified under CS-E 800 'Bird Strike and Ingestion'.

(b) For the demonstration under point (a), the altitude range within which the velocity V_H is evaluated should be defined and should not exceed 2 438 m (8 000 ft).

[Amdt No: 29/10]

SUBPART E — POWERPLANT

ROTOR DRIVE SYSTEM

[…]

AMC1 29.917 Rotor drive system design

VIBRATION HEALTH MONITORING

This AMC provides further guidance and acceptable means of compliance to supplement Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C, § AC 29.917~~, to meet EASA's interpretation of CS 29.917~~. As such, it should be used in conjunction with the FAA AC.

This AMC clarifies the scope of complying with CS 29.1465, where the applicant uses vibration health monitoring as a compensating provision to meet CS 29.917(b).

Where ~~V~~vibration ~~H~~health ~~M~~monitoring is used as a compensating provision to meet CS 29.917(b), the competent authority should approve the design and performance of the vibration health monitoring system ~~should be approved~~ by requesting compliance with CS 29.1465(a).

[Amdt No: 29/5]

[Amdt No: 29/10]

AMC2 29.917 Rotor drive system design

LUBRICATION SYSTEMS

This AMC provides further guidance and acceptable means of compliance to supplement Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C, § AC 29.917(b). As such, it should be used in conjunction with the FAA AC.

This AMC addresses the applicant's dedicated safety assessment of the rotor drive system's lubrication system and details how to use this assessment to help the applicant comply with CS 29.927(c).

For lubrication systems: a dedicated safety assessment should be performed that addresses all the lubrication systems of rotor drive system gearboxes and, in particular, the following:

(a) Identification of any single failure, malfunction, or reasonably conceivable combinations of failures that may result in a loss of oil pressure, a loss of oil supply to the dynamic components or a loss of the oil scavenge function. This normally takes the form of a failure mode and effects analysis. Compensating provisions should be identified to minimise the likelihood of occurrence of these failures. The safety assessment should also consider potential assembly or maintenance errors that cannot be readily detected during specified functional checks.

(b) The safety assessment should consider any specific design features which are subject to variability in manufacture or wear/degradation in service and which could have an appreciable effect on the *maximum period of operation following loss of lubrication*. Any features that may have a significant influence on the behaviour of the residual oil or the auxiliary lubrication system should be taken into account when determining the configuration of test articles.

(c) Identification of the *most severe failure mode* that results in the shortest duration of time in which the gearbox should be able to operate following the indication to the flight crew of a *normal-use lubrication system* failure. This should be used for simulating lubrication failure during the ~~CS 29.927(c)~~ loss-of-lubrication test described in CS 29.927(c).

(d) *Auxiliary lubrication system:* Where compliance with CS 29.927(c) is reliant upon the operation of an *auxiliary lubrication system*, sufficient independence between the *normal-use* and *auxiliary lubrication systems* should be substantiated. Common-cause failure analysis, including common-mode, particular-risk, and zonal safety analyses, should be performed. It should be established that no single failure or identified common-cause failure will prevent the operation of both the *normal-use* and the *auxiliary lubrication systems*, apart from any failures that are determined to be *extremely remote lubrication failures*. The effects of inadvertent operation of the *auxiliary lubrication system* should also be considered.

(e) Definitions

(1) *Lubrication ~~S~~system ~~F~~failure:* in the context of CS 29.917(b), references to a failure of the lubrication system should be interpreted as any failure that results in a loss of pressure and an associated low oil pressure warning, within the duration of one flight.

(2) *Most severe failure mode:* the failure mode *of the normal use lubrication system* that results in the shortest duration of time in which the gearbox is expected to operate following an indication to the flight crew.

(3) *Normal-use lubrication system:* the lubrication system relied upon during normal operation.

(4) *Auxiliary lubrication system:* any lubrication system that is *independent* of the *normal-use lubrication system*.

(5) *Independent:* an *auxiliary lubrication system* should be able to function after a failure of the *normal-use lubrication system*. Failure modes which may result in the subsequent failure of both the *auxiliary and the normal-use lubrication systems* and which may prevent continued safe flight or safe landing should be shown to be *extremely remote lubrication failures*.

(6) *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.*

(f) Determination of the *Most Severe Failure Mode*

(1) The objective of the loss-of-lubrication test is to demonstrate the operation of a rotor drive system gearbox following the *most severe failure mode* of the *normal-use lubrication system*. The determination of the *most severe failure mode* may not be immediately obvious, as leakage rates vary, and system performance following leaks from different areas varies as well. Thus, a careful analysis of the potential failure modes should be conducted, taking into account the effects of flight conditions if relevant.

(2) The starting point for the determination of the *most severe failure mode* should be an assessment of all the potential lubrication system failure modes. This should be accomplished as part of the CS 29.917(b) design assessment, and should include leaks from any connections between components that are assembled together, such as threaded connections, hydraulic inserts, gaskets, seals, and packing (O-rings). Failure modes, such as failures of external lines, failures of component retention hardware and wall-through cracks that have not been substantiated for CS 29.307, CS 29.571 and CS 29.923(m) should also be considered. The determination that a failure is an *extremely remote lubrication failure*, when used to eliminate a potential failure mode from being considered as a candidate *most severe failure mode*, should be substantiated. Where leakage rates or the effect of failure modes cannot be easily determined, then a laboratory test should be conducted. Once the *most severe failure mode* has been determined, this should form the basis of the conditions for the start of the test.

(g) Use of an *auxiliary lubrication system*

The u~~U~~se of an *auxiliary lubrication system* may be an acceptable means of providing extended operating time after a loss of lubrication. The *auxiliary lubrication system* should be designed to provide sufficient independence from the *normal-use lubrication system*. Since the *auxiliary lubrication system* is by definition integral to the same gearbox as the *normal-use lubrication system*, it may be impractical for it to be completely independent. Therefore, designs should be conceived such that shared components or interfaces between the *normal-use* and *auxiliary lubrication systems* are minimised and comply with the design assessment provisions of CS 29.917(b). A failure of any common feature shared by both the *normal-use* and *auxiliary lubrication systems* that could result in the failure of both systems, and would consequently reduce the *maximum period of operation following loss of lubrication,* should be shown to be an *extremely remote lubrication failure*. If compliance with CS 29.927(c) is reliant on the functioning of an *auxiliary lubrication system*, then:

(1) in the unlikely event of a combined failure of both the *normal-use lubrication system* and the *auxiliary lubrication system*, the RFM emergency procedures should instruct the flight crew to 'LAND IMMEDIATELY' unless testing representing this failure mode has been performed in order to substantiate that an increased duration is justified; and

(2) a means of verifying that the *auxiliary lubrication system* is functioning properly should be provided during normal operation of the rotorcraft on either a periodic, pre-flight or continual basis. Following a failure of the normal-use lube system and activation of an

auxiliary lubrication system, the flight crew should be alerted in the event of any system malfunction.

(h) Independence of the *auxiliary lubrication system*.

(1) In order to ensure that the *auxiliary lubrication system* is sufficiently independent:

(i) a failure of any pressurised portion of the *normal-use lubrication system* should not result in a subsequent failure of the *auxiliary lubrication system*;

(ii) common failure modes shown to defeat both the *normal-use* and the *auxiliary lubrication systems* should be shown to be *extremely remote lubrication* failures, unless it is demonstrated by testing conducted to comply with CS 29.927(c) that the failure mode does not compromise the '*Maximum period of operation following loss of lubrication*'; and

(iii) control systems, logic and health-reporting systems should not be shared; consideration should be given to the design process to ensure appropriate segregation of the control and warning systems in the system architecture.

(2) Methods which should be used to demonstrate that failure modes of common areas are *extremely remote* include:

(i) field experience of the exact design with an exact application;

(ii) field experience with a similar design/application with supporting test data to allow a comparison;

(iii) demonstration by test of extremely low leakage rates;

(iv) redundancy of design;

(v) structural substantiation with a high safety margin for elements of the lubrication systems assessed against CS 29.571; and

(vi) assessment of the potential dormant failure modes of the *auxiliary lubrication system,* and in order to minimise the risk of dormant failures, determination of the health of the *auxiliary lubrication system* prior to each flight.

[Amdt No: 29/5]

[Amdt No: 29/10]

AMC3 29.917 Rotor drive system design

CHIP DETECTION SYSTEM

This AMC provides further guidance and acceptable means of compliance to supplement Federal Aviation Administration (FAA) Advisory Circular (AC) 29-2C, § AC 29.917(b). As such, it should be used in conjunction with the FAA AC.

This AMC contains additional considerations for each chip detection system that the applicant uses as a compensating provision to meet CS 29.917(b). For each chip detection system that the applicant uses as a compensating provision for hazardous or catastrophic failures to meet CS 29.917(b), this section introduces AMC to substantiate the chip detection system that is specified in CS 29.1337(e) as an appropriate compensating provision.

(a) The applicant may identify a chip detection system that is installed on a rotor drive system transmission or gearbox as a compensating provision in the rotor drive system design assessment to comply with CS 29.1337(e). The chip detection system that is used as a compensating provision is intended to minimise the likelihood of occurrence of certain failures in transmissions and gearboxes, including hazardous and catastrophic failures.

(b) To be accepted as an appropriate compensating provision, the chip detection system should effectively indicate the presence of ferromagnetic particles that are released due to damage or excessive wear. That damage or excessive wear could lead to the failures whose likelihood of occurrence the chip detection system is intended to minimise. As a result, to demonstrate compliance with CS 29.917(b), the applicant should substantiate the effectiveness of the chip detection system for all the identified hazardous and catastrophic failure modes through full-scale test evidence.

(c) The test(s) that are performed to demonstrate compliance with CS 29.917(b) should address all those areas of the rotor drive system that are associated with the failures for which the chip detection system is identified as a compensating provision. AMC1 29.1337 provides further guidance on the use of full-scale testing as a means to demonstrate the compliance of the chip detection system. It also defines performance objectives that the applicant should meet to demonstrate the general level of effectiveness of the system. However, the applicant should specifically assess the amount of ferromagnetic particles and use the value of 60 mg that is provided in AMC1 29.1337(e) only if supported by that assessment. This means that an amount of particles is justified to be released with sufficient margin before a hazardous or catastrophic failure occurs.

Note: the applicant should not consider that demonstrating the effectiveness of a chip detection system to comply with CS 29.917(b) and CS 29.1337(e) is an alternative to providing a robust and reliable design, or a means to relieve the applicant of demonstrating compliance with other necessary compensating provisions.

[Amdt No: 29/10]

[…]

AMC1 29.927(c) Additional tests

[…]

(a) Explanation

(1) […] The failure condition to be simulated is the *most severe loss of lubrication failure* mode of the *normal-use lubrication system*, which is defined in AMC2 29.917(b).

[…]

[Amdt No: 29/5]

[Amdt No: 29/10]

SUBPART F —– EQUIPMENT

GENERAL

[…]

CS 29.1305 Power plant instruments

The following are required power plant instruments:

(a) For each rotorcraft:

[…]

(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

[…]

[Amdt No: 29/2]

[Amdt No: 29/10]

INSTRUMENTS: INSTALLATION

[…]

CS 29.1337 Power plant ~~I~~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 wear within the transmission or gearbox. Each chip ~~detector~~detection system must:

(1) ~~B~~be designed to provide a signal to the ~~indicator required by~~warning or caution devices in accordance with CS 29.1305~~-~~(a)(23); and

(2) ~~B~~be provided with a means to allow crew members to check or to be informed of, in flight, whether the electrical circuit of the chip detection system function correctly.~~the function of each detector electrical circuit and signal.~~

[Amdt No: 29/10]

AMC1 29.1337(e) Power plant instruments

CHIP DETECTION SYSTEM

This AMC provides further guidance and acceptable means of compliance to supplement Federal Aviation Administration (FAA) Advisory Circular (AC) 29-1B, § AC 29.1337. As such, it should be used in conjunction with the FAA AC.

The applicant should consider the following aspects of chip detection systems:

(a) Chip detection effectiveness

The effectiveness of the chip detection system should be understood as its capability to indicate the presence of ferromagnetic particles within a transmission or a gearbox. As a chip detection system requires these ferromagnetic particles to be near its sensing element(s) (chip detector(s)), its effectiveness depends on the following:

— the design of the rotor drive system's transmission or gearbox, which may help or prevent released ferromagnetic particles to move to the chip detector location(s);

— the location of the chip detector; and

— the design of the chip detector.

(b) Demonstration of effectiveness

As specified in CS 29.1337(e), the applicant should demonstrate that a chip detection system that is installed in a rotor drive system's transmission or gearbox effectively indicates the presence of ferromagnetic particles resulting from damage or excessive wear within the transmission or gearbox. For this purpose, the applicant should consider the approach that is described in this section.

As mentioned above, the design of the transmission or gearbox, and the location of the chip detectors within them also affect the effectiveness of a chip detection system. As a result, when assessing the effectiveness of a chip detection system, the applicant should consider the characteristics of the complete transmission or gearbox. Hence, as part of the demonstration of the effectiveness of a chip detection system, the applicant should demonstrate that the system can consistently generate a caution/warning signal, within an acceptable period of time, of a limited amount of representative ferromagnetic particles being released. In doing so, the applicant should also consider the characteristics of the corresponding transmission or gearbox, such as oil ways and flow paths towards the chip detectors.

To demonstrate the effectiveness of a chip detection system, the applicant should perform a preliminary design assessment. This assessment should address all the areas of the transmission or gearbox from which ferromagnetic particles could be released, as well as the expected paths through which the particles reach the chip detectors. The assessment should identify those design features that might prevent particles from reaching a chip detector. In general, the areas of the transmission or gearbox to be considered for this evaluation should:

— include main and/or tail rotor drive path;

— include other areas that could affect the correct transmission of torque to main and/or tail rotors; and

— focus on features such as the contact locations of bearings, gears, and shafts that are internal to the transmission or gearbox.

The applicant should use the outcome of the preliminary design assessment to determine the need for testing of each relevant area of the rotor drive system transmissions and gearboxes. If the applicant can justify that a location or area provides a conservative result, compared to other locations, the number of areas to be tested could be optimised. The preliminary design assessment should also determine those areas for which sufficient information is available from representative tests and in-service experience from previous designs.

Based on the conclusions of the preliminary design assessment, the applicant should determine the effectiveness of a chip detection system through a combination of the following two elements:

(1) a full-scale certification test of the transmission or gearbox by artificially introducing ferromagnetic particles.

The applicant should run this test in a series of phases, with measured amounts of ferromagnetic particles. The applicant should establish the quantity of ferromagnetic particles and the time needed to generate the caution/warning signal specified by CS 29.1305(a)(23) for each relevant area of the transmission or gearbox. The applicant should use this compliance method for those areas of transmissions or gearboxes whose effectiveness cannot be confidently established by a detailed design assessment as described in point (2).

In addition, the applicant should:

— perform the full-scale certification test in a fully representative gearbox, including its lubrication system. For gearboxes with pressurised lubrication, the applicant may replace some external elements of the lubrication system by test equipment, which can be justified to have no impact on the results.

— perform the full-scale certification test at a fixed attitude, rotational speed, and lubricating-oil temperature, corresponding to those at which the gearbox is expected to operate the most. The torque that is transmitted by the gearbox is considered irrelevant for this test.

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

— test each area that is identified for testing in a dedicated test phase, unless the applicant can justify that testing more than one area at the same time will still produce representative results for each area; and

— have a test procedure that ensures no contamination between the test phases. This often requires disassembling and thoroughly cleaning the gearbox being tested after each test phase.

(2) Detailed design assessment, using test data to support the performance of the relevant chip detectors in their local environments.

The applicant should use this assessment to demonstrate that the design provisions are adequate to ensure that the ferromagnetic particles that are released due to damage or excessive wear in the relevant locations will reach at least one chip detector. Sufficient test data to support the performance of the relevant chip detectors in representative environments should be available to demonstrate that the caution/warning signal that is specified in CS 29.1305(a)(23) is generated. When assessing the available test data, the applicant should consider that based on the area of the transmission or gearbox where the particles originate, additional test points may be needed, depending on the design of the chip detectors and of the areas around them. If the design of the transmission or gearbox has questionable features that may trap particles or impede their progress, representative test data or in-service experience that demonstrate the impact of these features on the effectiveness of the chip detection system should be available to support the assessment.

The applicant may obtain supporting test data from representative full-scale tests, previous similar designs and/or components, or sub-assembly tests, as appropriate.

To demonstrate the effectiveness of the chip detection system, as described in this section, the applicant should also ensure that the chip detection system performs its intended function under any expected operating conditions. Therefore, the applicant should consider, through design analysis and/or dedicated testing, any aspects of the chip detection system and of the elements in which it is installed (i.e. gearboxes and transmissions) that could affect the effectiveness of the system. These aspects should include the following:

— attitude of the rotorcraft;

— temperature and viscosity of the oil; and

— exact location from which the ferromagnetic particles originate, and the vicinity of potential retention features.

~~To demonstrate the effectiveness of a chip detection system, the applicant should carry out a detailed design assessment, using representative test data that support the performance of the relevant chip detectors in their local environments.~~

~~The applicant should use this assessment to demonstrate that the design provisions are adequate to ensure that the ferromagnetic particles that are released due to damage or excessive wear in the relevant locations will reach at least one chip detector. Sufficient test data to support the performance of the relevant chip detectors in representative environments should be available to demonstrate that the caution/warning signal that is specified in CS 29.1305(v) is generated. When assessing the available test data, the applicant should consider that based on the area of the transmission or gearbox where the particles originate, additional test points may be needed, depending on the design of the chip detectors and of the areas around them. If the design of the transmission or gearbox has questionable features that may trap particles or impede their progress, representative test data or in-service experience that demonstrate the impact of these features on the effectiveness of the chip detection system should be available to support the assessment.~~

~~The applicant may obtain supporting test data from representative full-scale tests, previous similar designs and/or components, or sub-assembly tests, as appropriate.~~

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~~elements in which it is installed (i.e. gearboxes and transmissions) that could affect the effectiveness of the system. These aspects should include the following:~~

— ~~attitude of the rotorcraft;~~

— ~~temperature and viscosity of the oil; and~~

— ~~exact location from which the ferromagnetic particles originate, and the vicinity of potential retention features.~~

(c) Acceptable level of effectiveness

This section provides an acceptable measure for demonstrating the effectiveness of the chip detection system that is described in point (b).

An acceptable level of effectiveness is demonstrated when the chip detection system generates a caution/warning signal following the release of an amount of ferromagnetic particles. The applicant should justify that this amount results from the damage or excessive wear caused by the failure modes of the specific area of the transmission or gearbox under assessment. Alternatively, the applicant may choose to use 60 mg of ferromagnetic particles.

In addition, no more than 20 minutes should elapse between the introduction of the first ferromagnetic particles and the generation of the caution/warning signal by the chip detection system. However, if the applicant demonstrates that a specific design feature of the chip detection systems consistently leads to effective detection in a period greater than 20 min, the adequacy of that system may be considered on a case-by-case basis.

When demonstrating the effectiveness of the chip detection system, the applicant should consider particles with characteristics (shapes, sizes, densities, and magnetic properties) representative of the damage or excessive wear associated with the areas being tested.

(d) Other considerations

(1) Reliability considerations

CS 29.1337(e) focuses on the overall effectiveness of the chip detection system. The assumption is made that the electrical elements of the system, the chip detector(s), and the instruments function reliably due to good design practices and compliance with the applicable requirements for electrical systems.

(2) Design considerations

(i) Flat oil sumps can significantly limit the capability of ferromagnetic particles, coming from different locations in the transmission or gearbox, that need to move across the sump to reach a chip detector. Therefore, the applicant should normally use substantiating test data to support the certification of this type of design feature.

Note: if the applicant has successfully performed tests in accordance with point (b), no further test data are necessary.

(ii) When designing rotor drive system transmissions and gearboxes, the applicant should ensure that the flow path of the lubricating oil that is intended to carry ferromagnetic particles is directed to the locations of the chip detectors. The location, orientation, and flow of oil jets may affect the movement of the ferromagnetic particles subject to their influence.

(iii) The applicant should avoid, wherever possible, specific features, such as cavities or pockets that could act as retention features for ferromagnetic particles.

(iv) In pressure-lubricated gearboxes, ferromagnetic particles may be drawn into the lubrication circuit at the pump intake. This can be advantageous for locating chip detectors. However, the applicant should carefully consider that the chip detection system may require particles to be acquired and retained, allowing them to be recovered and analysed. Thus, areas of strong oil flow should be carefully considered, ensuring that final location is defined and implemented in the design for particle recovery.

For non-pressure-lubricated gearboxes, the applicant should place the chip detector at the lowest point of the system.

(3) <u>Maintenance and ICA considerations</u>

The applicant should consider that CS 29.1337(e) focuses on the fitment of a chip detection system. That system should be an effective means to indicate the presence of ferromagnetic particles in rotor drive system transmissions and gearboxes, which may be caused by damage or excessive wear. It should also be capable to indicate the presence of such particles and to be checked in flight. However, following the detection of such particles by the rotorcraft chip detection system, additional actions are typically needed to ensure the airworthiness of the rotorcraft. The applicant should define the following actions in the instructions for continuing airworthiness (ICA):

— instructions to assess findings from any indication from the chip detection system, which may involve:

  — analysis of the quantity and characteristics of the ferromagnetic particles that are detected and retrieved, and/or

  — maintenance checks to retrieve additional ferromagnetic particles from other areas of the rotor drive system, such as the oil filter of the lubrication system;

— specific criteria to establish whether any findings may indicate that parts of the affected transmission or gearbox are subject to damage or wear and require to be restored to a serviceable condition; and

— additional inspections in support of continued operation when the aforementioned criteria are not reached.

In addition, the applicant may consider complementing the caution/warning signal of the chip detection system by regular inspection of the chip detector(s) and/or other elements of the transmission or gearbox where ferromagnetic particles may be located.

Finally, the applicant should ensure that the reliability of the system is maintained in service by conducting the necessary in-flight and maintenance checks to verify that the elements of the chip detection system function correctly.

[Amdt No: 29/10]

GM1 29.1337(e) Power plant instruments

CHIP DETECTION SYSTEM

The chip detection system typically includes one or more sensing elements (i.e. 'chip detectors') per transmission or gearbox. Those chip detectors have the function of detecting the presence of ferromagnetic particles and generating a caution/warning signal. The chip detection system also includes the connectors' wiring, as well as the hardware unit for processing the caution/warning signal, if needed, transferring it, and generating the warning or caution required by CS 29.1305(a)(23).

[Amdt No: 29/10]