European Union Aviation Safety Agency

Explanatory Note to ED Decision 2024/009/R

in accordance with Article 6 of MB Decision 01-2022

Reduction in accidents caused by failures of critical rotor and rotor drive components through improved vibration health monitoring systems

RMT.0711

EXECUTIVE SUMMARY

The use of vibration health monitoring (VHM) systems to monitor the condition of critical rotor and rotor drive components has been demonstrated to improve incipient fault detection capabilities by complementing those provided by traditional inspection techniques. However, the current acceptable means of compliance (AMC) are not sufficient to ensure that these systems can be certified to be used to optimise the continuing airworthiness for rotorcraft systems.

The regulatory material issued with this Decision identifies ways to certify VHM systems so that they can be a more integral part of the continuing airworthiness process of the rotorcraft and to provide better and updated guidance on the design and operation of these systems, as well as on their effective in-service use. This will result in VHM systems supporting the optimisation of the continuing airworthiness of the rotor and rotor drive systems, thus, reducing the risk of maintenance errors and, potentially, increasing the likelihood of early fault detection.

The amendment to the AMC to CS 29.1465 clarifies the means for establishing compliance where VHM applications are used for airworthiness-related purposes for the rotor and/or rotor drive system. In addition, the guidance provided in this AMC and in the newly developed GM should help to promote the development of VHM systems with improved fidelity and reliability.

With this regulatory material, the European Union Aviation Safety Agency (EASA) addresses the safety recommendation received by EASA (UNKG-2018-007) related to an accident that occurred on 28 December 2016 at the West Franklin wellhead platform, North Sea, UK, involving a Sikorsky S-92A helicopter (registered G-WNSR).

REGULATION(S) TO BE AMENDED/ISSUED	**ED DECISIONS TO BE ISSUED**
n/a	ED Decision 2024/009/R ‘CS-29 — Amendment 12’

AFFECTED STAKEHOLDERS DOA holders

WORKING METHOD(S)		
Development	**Impact assessment(s)**	**Consultation**
By EASA	Light	Public — NPA

Related documents / information

- ToR RMT.0711, issued on 5 March 2020
- NPA 2022-03
- CRD 2022-03

PLANNING MILESTONES: Refer to the latest edition of *EPAS Volume II*.

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1. About this Decision

EASA identified the need to mitigate a safety risk and rulemaking as the necessary intervention action.

This rulemaking activity is included in the 2024 edition of Volume II of the European Plan for Aviation Safety (EPAS) for 2023–2025[1] under Rulemaking Task (RMT).711.

EASA developed the regulatory material in question in line with Regulation (EU) 2018/1139[2] (the Basic Regulation) and the Rulemaking Procedure[3], as well as in accordance with the objectives and working methods described in the Terms of Reference (ToR) for this RMT[4]. When developing the regulatory material, EASA was supported by Rulemaking Group (RMG) RMT.0711.

The draft regulatory material was consulted in accordance with the ToR for this RMT through NPA 2022-03[5]. Comments were received from interested parties, including industry and national competent authorities (NCAs).

EASA reviewed the comments received and duly considered them.

1 European Plan for Aviation Safety (EPAS) 2024 - 13th edition | EASA (europa.eu)

2 Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (http://data.europa.eu/eli/reg/2018/1139/oj).

3 EASA is bound to follow a structured rulemaking process as required by Article 115(1) of Regulation (EU) 2018/1139. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 01-2022 of 2 May 2022 on the procedure to be applied by EASA for the issuing of opinions, certification specifications and other detailed specifications, acceptable means of compliance and guidance material ('Rulemaking Procedure'), and repealing Management Board Decision No 18-2015 (EASA MB Decision No 01-2022 on the Rulemaking Procedure, repealing MB Decision 18-2015 (by written procedure) | EASA (europa.eu)).

4 ToR RMT.0711 - Reduction in accidents caused by failures of critical rotor and rotor drive components through improved vibration health monitoring systems | EASA (europa.eu)

5 NPA 2022-03 - Reduction in accidents caused by failures of critical rotor and rotor drive components through improved vibration health monitoring systems | EASA (europa.eu)

2. In summary — why and what

2.1. Why we need to act

Rotorcraft are potentially more vulnerable to catastrophic mechanical failures than fixed-wing aeroplanes due to their reliance on the integrity of single-load-path critical components within the rotor and rotor drive systems. Depending on the methodology applied by the type certificate holder (TCH) and their designs, there can be more than a hundred critical parts within the rotor and rotor drive systems. A single failure of any of these critical parts can result in catastrophic consequences upon the rotorcraft.

In the past, traditional methods for health monitoring were not able to provide a reliable early warning of certain failure modes, including fatigue cracking. It was this vulnerability and the high rotorcraft accident rate in the 1970s and 1980s that led to the development of VHM systems that are able to monitor the health and integrity of rotor and rotor drive systems.

Dedicated certification specifications (CSs) for VHM were included in CS-29 in 2012 (ref. CS 29.1465) along with the associated AMC. Since the development and introduction of these CSs and AMC for VHM systems, there have been improvements with regard to the capability of these systems, the processing techniques used, and the understanding of the dynamic behaviour of the components that are being monitored. Therefore, the potential now exists to place a greater level of reliance on these systems to help prevent failures in rotors and rotor drive systems. This requires changes, certain updates and improvements of the AMC, based on experience that has been gathered from the application of CS 29.1465 in various certification projects.

The following safety recommendation (SR), addressed to EASA, from an aircraft accident investigation report, and published by the designated safety investigation authority[6], is considered for this RMT.

UNKG-2018-007:

'It is recommended that the European Aviation Safety Agency amend the regulatory requirements to require that Vibration Health Monitoring data gathered on helicopters is analysed in near real-time, and that the presence of any exceedance detected is made available to the flight crew on the helicopter; as a minimum, this information should be available at least before takeoff and after landing.'

This was related to an accident that occurred on 28 December 2016 at the West Franklin wellhead platform, North Sea, UK, involving a Sikorsky S-92A helicopter registered G-WNSR.

Other SRs addressed to EASA, which are associated with VHM systems that are not directly related to the objectives of this RMT, have also been taken into consideration to ensure consistency.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. The regulatory material presented here is expected to contribute to achieving these overall objectives by addressing the issue described in Section 1.2

[6] Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC (OJ L 295, 12.11.2010, p. 35) (http://data.europa.eu/eli/reg/2010/996/oj).

More specifically, with the regulatory material presented here, EASA intends to reduce the likelihood of hazardous and catastrophic failure modes by improving the incipient fault detection capabilities of current inspection procedures. This will be achieved by enabling VHM systems to be a more integral part of the continued airworthiness regime of the rotorcraft and by ensuring that better and updated guidance is provided for the design as well as the routine and effective in-service use of these systems. It is considered that this will result in VHM systems supporting the optimisation of the continuing airworthiness of the rotor and rotor drive systems, thus, reducing the risk of maintenance errors and, potentially, increasing the likelihood of early fault detection.

2.3. Who is affected by the issue

As the compliance with CS 29.1465 is not mandatory (it depends on the application), only the DOA holder that decides to apply for a VHM system that performs certain functions will be impacted.

2.4. How could the issue evolve

Recent developments in VHM systems enable more effective monitoring of the health and integrity of rotor and rotor drive systems. The potential now exists to place a greater level of reliance on these systems to help prevent failures in rotors and rotor drive systems. This involves revising the AMC to reflect the progress in the domain.

In the past, traditional methods for health monitoring were not able to provide a reliable early warning of certain failure modes, including fatigue cracking. Recent developments will help prevent failures in rotors and rotor drive systems. If no action is taken, the current situation will remain unchanged and a substantial gain in the level of aviation safety would not be used despite the potential proven through recent developments.

2.5. How we want to achieve it

The objectives defined in Section 2.2 can be achieved by improving and amending the available AMC for VHM systems that is included in CS-29. AMC1 29.1465 is amended to accommodate the application and demonstration of adequate reliability and effectiveness of VHM systems that are used as the monitoring means in the support of on-condition maintenance activities of elements of the rotor and rotor drive system. Additionally, some improvements to the existing content are introduced to clarify certain aspects of certification of VHM systems taking into consideration their intended application.

In particular, AMC1 29.1465 is amended by:

— defining criteria for the acceptance of VHM systems as an airworthiness approved means for optimisation of the continuing airworthiness;

— defining high-level objectives for VHM applications used for airworthiness-related purposes, and providing additional considerations regarding the characteristics to be demonstrated for elements of the rotor and rotor drive system and their failure modes that are being monitored for this purpose;

— establishing appropriate principles concerning the definition of adequate targets for controlled service introduction (CSI) phases, taking into consideration the intended use of the different VHM system indicators, and additionally, clarifying the requirements for the performance assessment of VHM systems during these phases;

— clarifying the intent of VHM trend monitoring and the objectives of its implementation;

— defining advanced anomaly detection techniques, and the scope of their application as part of VHM monitoring;

— defining recommended criteria for evaluating the performance of health indicators and the associated thresholds;

— clarifying the depth of initial and CSI investigations expected for elements of the VHM system, such as ground stations, product support, and recommendations for training.

2.6. What are the stakeholders' views

During the public consultation, EASA received 225 comments from 12 commentators. 5 commentators represented the national competent authorities (NCAs) and 7 commentators represented industry and a helicopter operator association.

Most of the comments came from industry and focus on the technical content of the AMC.

Generally, the commenters supported the proposal but highlighted that some concepts need to be further developed. The following issues were addressed in the comments:

— clarification on the potential uses of safety factors;

— update of the quantitative safety objectives towards a 'stepped' approach, and possibility, when in between cases, for intermediate commensurate solutions to be proposed;

— updates of the performance section of the VHM system to clarify:

  — the specific performance objectives as approximate reference standards; and

  — the purpose of the CSI for applications for credit and applications for compliance with an operational regulation;

— update of the VHM system safety requirements to separate the identification of qualitative and quantitative safety objectives and a clarification regarding the probability of occurrence of any degraded condition.

Some terms were clarified and some concepts have been further developed to address the comments received.

EASA has organised a series of teleconferences and one face-to-face workshop with the working group to discuss and update the proposed AMC. The final AMC and GM text is the result of these additional discussions. The AMC and GM are considered sufficiently mature and to be adequately tackling industry concerns, as well as gaps in certification policies. No substantial comment is understood to remain open by any of the organisations present in the working group.

3. What are the expected benefits and drawbacks of the regulatory material

Compliance with CS 29.1465 is not mandatory and the main intent is to clarify what is expected if applicants decide to apply for a VHM system that performs certain functions and to improve aspects of the existing AMC. Overall, this will improve safety, will have no social or environmental impacts, and will provide economic benefits by streamlining the certification process and providing better means of compliance as well as guidance to applicants. No drawbacks have been identified.

4. Related documents

CRD 2022-03 ‘Reduction in accidents caused by failures of critical rotor and rotor drive components through improved vibration health monitoring systems’

5. Monitoring and evaluation

As the compliance with CS 29.1465 is not mandatory and the main intent of the RMT is to clarify what is expected if applicants decide to apply for a VHM system that performs certain functions and to improve aspects of the existing AMC, development of monitoring and evaluation measures are not possible.

6. Proposed actions to support implementation

None intended.

7. References

7.1. Related EU regulations

N/A

7.2. Related EASA decisions

Decision No. 2003/16/RM of the Executive Director of the Agency of 14 November 2003 on certification specifications for large rotorcraft ('CS-29')

7.3. Other references

— AC 29 MG 1 Certification Procedure for Rotorcraft Avionics Equipment

— AC 29 MG 15 Airworthiness Approval of Rotorcraft Health Usage Monitoring Systems (HUMS)

— AC 29.571B. § 29.571 (Amendment 29-55) Fatigue tolerance evaluation of metallic structure. – f.(10) Approved Equivalent Means

— AC 29.547A. § 29.547 (Amendment 29-40) Main rotor and tail rotor structure

— AC 29.547A. § 29.917 (Amendment 29-40) Design

— AC 29.1309. § 29.1309 (Amendment 29-40) Equipment, systems and installations

— EUROCAE ED-79A / SAE ARP 4754A Guidelines for development of civil aircraft and systems

— SAE ARP5783 Health and Usage Monitoring Metrics

— AMC 20-115 Airborne Software Development Assurance Using EUROCAE ED-12 and RTCA DO-178

— EUROCAE ED-12 / RTCA DO-178 Software Considerations in Airborne Systems and Equipment Certification

— EUROCAE ED-215 / RTCA DO-330 Software Tool Qualification Considerations

— EUROCAE ED-109 / RTCA DO-278 Software Integrity Assurance Considerations for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems