

**Leonardo AW169,
G-VSKP**

**King Power Stadium,
Leicester**

27 October 2018

Accident

Investigation Synopsis

At 1937 hrs the helicopter, carrying the pilot and four passengers, lifted off from the centre spot of the pitch at the King Power Stadium. The helicopter moved forward and then began to climb out of the stadium on a rearward flightpath while maintaining a northerly heading and with an average rate of climb of between 600 and 700 ft/min. Passing through a height of approximately 250 ft, the pilot began the transition to forward flight by pitching the helicopter nosedown and the landing gear was retracted. The helicopter was briefly established in a right turn before an increasing right yaw rapidly developed, despite the immediate application of corrective control inputs from the pilot. The helicopter reached a radio altimeter height of approximately 430 ft before descending with a high rotation rate. At approximately 75 ft from the ground the collective was fully raised to cushion the touchdown.

The helicopter struck the ground on a stepped concrete surface, coming to rest on its left side. The impact, which likely exceeded the helicopter's design requirements, damaged the lower fuselage and the helicopter's fuel tanks which resulted in a significant fuel leak. The fuel ignited shortly after the helicopter came to rest and an intense post-impact fire rapidly engulfed the fuselage.

During the course of this investigation and as a result of the findings made, the helicopter manufacturer has issued sixteen Service Bulletins and The Easa has published nine Airworthiness Directives for the continued airworthiness of AW169 and AW189 helicopter types.

Eight Safety Recommendations have been made in this report. These have been made to The EASA to address weaknesses or omissions identified in the regulations for the certification of large helicopters – Certification Specification 29. The recommendations address the main findings of the investigation and include: validation of design data by suppliers post tes; premature rolling contact fatigue in bearings; life limits, load spectrum safety margin and inspection programmes for critical parts; and assessment and mitigation of catastrophic failure modes in systems.

Safety Recommendation 2023-018

Justification

Where subcontract suppliers hold the sole expertise to analyse the significance of a component they design and qualify against a specification, it is essential that the type design manufacturer shares all the subsequent data obtained from the installed rig and flight tests during development. This provides the opportunity for a 'closed loop' validation by the specialist manufacturer of their component within the system application in which it will be used. This is particularly significant for critical parts, where component failure has catastrophic implications.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-018

It is recommended that the European Union Aviation Safety Agency amend Certification Specification 29.602 to require type design manufacturers to provide the results of all relevant system and flight testing to any supplier who retains the sole expertise to assess the performance and reliability of components identified as critical parts within a specific system application, to

verify that such components can safely meet the in-service operational demands, prior to the certification of the overall system.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 29 November 2024

Pursuant to point 21.A.20 of Annex I (Part 21) to Regulation (EU) No 748/2012, the applicant for aircraft type certification is responsible for the demonstration of compliance with the type certification basis (that includes certification specifications), and to record justifications of compliance within the compliance documents as referred to in the certification programme. This implies ensuring that parts and systems reach minimum performance and reliability targets.

Therefore, the applicant is responsible for providing any information such as, but not limited to, test results to its suppliers to ensure a final airworthy design.

This principle is not specific to certain products and should not be repeated in each Certification Specification where a supplier could be affected.

The European Union Aviation Safety Agency (EASA) considers that the above-mentioned regulatory framework, including Certification Specifications, is adequate and does not envisage creating new prescriptive requirements.

EASA Status: Closed – Partial agreement

Safety Recommendation Status Closed

AAIB Assessment Not Adequate

Action Status No Planned Actions

Feedback rationale

The AAIB acknowledges the EASA has reviewed their response as a result of AAIB feedback and has not changed its position on this recommendation (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 06 February 2024

Pursuant to point 21.A.20 of Annex I (Part 21) to Regulation (EU) No 748/2012, the applicant for aircraft type certification is responsible for the demonstration of compliance with the type certification basis (that includes certification specifications), and to record justifications of compliance within the compliance documents as referred to in the certification programme. This implies ensuring that parts and systems reach minimum performance and reliability targets.

Therefore, the applicant is responsible for providing any information such as, but not limited to, test results to its suppliers to ensure a final airworthy design.

This principle is not specific to certain products and should not be repeated in each Certification Specification where a supplier could be affected.

The European Union Aviation Safety Agency (EASA) considers that the above-mentioned regulatory framework, including Certification Specifications, is adequate and does not envisage creating new prescriptive requirements.

AAIB Assessment – Not Adequate Closed

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-019

Justification

AMC for CS 29.571 provides guidance to manufacturers to at consider rolling contact fatigue within their analysis. However, this regulation is aimed at Principal Structural Element (PSE) components within a power drivetrain, rather than critical components within a control system, such as the duplex tail rotor bearing. The tail rotor which included the duplex bearing was certified to CS 29.547, so the manufacturer would not have considered CS 29.571 during the tail rotor design process. Only the Acceptable Means of Compliance has been amended and this states RCF should be considered during the analysis, as such it does not introduce any specific criteria, which must be met and demonstrated during certification, to ensure an appropriate minimum safety standard when dealing with components whose failure is assessed as catastrophic or hazardous.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-019

It is recommended that the European Union Aviation Safety Agency introduce additional requirements to Certification Specification 29 to specifically address premature rolling contact fatigue failure across the full operating spectrum and service life of bearings used in safety critical applications.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 06 February 2024

Point CS 29.571 (Fatigue Tolerance Evaluation of Metallic Structure) paragraph (d) of Certification Specification for Large Rotorcraft (CS-29) specifies the following with regard to Principle Structure Elements (PSE):

“Each PSE must be identified. Structure to be considered must include the rotors, rotor drive systems between the engines and rotor hubs, controls, fuselage, fixed and movable control surfaces, engine and transmission mountings, landing gear, and their related primary attachments.”

The European Union Aviation Safety Agency (EASA) considers that this includes critical components within the rotor control mechanism, such as the tail rotor duplex bearing of the AW169.

Acceptable Means of Compliance AMC1 29.571 (introduced with Amendment 11 of CS-29) addresses Rolling Contact Fatigue (RCF) which should be included, when applicable, in the fatigue tolerance evaluation of Principle Structure Elements (PSE). This AMC describes possible steps to be taken to minimise the risk of crack initiation due to RCF on PSEs (and in particular for integrated bearing races). A fail-safe approach is recommended wherever possible, such that cracking of the affected structural element(s) is detected prior to its residual strength capability falling below the required levels prescribed in CS 29.571(f). In addition to following a fail-safe approach, inspection and retirement times may be needed in order to ensure that the assumptions supporting the fail-safety and detection of failure remain valid throughout the operational life of the component.

EASA is however reviewing the opportunity to clarify the scope of application of AMC1 29.571, and similarly of AMC1 27.571, to ensure that critical bearings are always considered. A proposed amendment of CS-27 and CS-29 is planned to be included in the next Notice of Proposed Amendment under rulemaking task RMT.0128 'Regular update of the Certification Specifications for Very Light Rotorcraft (CS-VLR), Small Rotorcraft (CS-27), and Large Rotorcraft (CS-29)'.

Safety Recommendation Status

Open

AAIB Assessment

Partially Adequate

Action Status

Planned Action Ongoing Update Due 06 February 2025

Feedback rationale

The AAIB acknowledges EASA's response and requests an update on the progress of the proposed amendment to CS-27 and CS-29 on or before 06 February 2025. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-020

Justification

The duplex bearing was identified as a critical part, as defined by CS 29.602, by the helicopter manufacturer because its failure was assessed as catastrophic, an assessment which has been validated by the circumstances of this accident. Analysis by its manufacturer of the bearing against the development load spectrum has also determined that it would have a finite life in this application, the mitigation for which is replacement before it reaches its anticipated failure life. The airworthiness considerations for non-structural critical parts are identified through assessment to demonstrate compliance with CS 29.602, but this regulation does not currently address life limits or their equivalent status to the ALS limits identified to comply with CS 29.571. As such, no specific rules or guidance are available to manufacturers to provide clarity on this issue.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-020

It is recommended that the European Union Aviation Safety Agency amend Certification Specification 29.602 to define the airworthiness status of life limits on non-structural critical parts and how they should be controlled in service.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 06 February 2024

Inspections and/or retirement times are introduced in the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness (ICA) based on:

1. The fatigue and damage tolerance evaluations performed when showing compliance with points CS 29.571 (Fatigue Tolerance Evaluation of Metallic Structure) and CS 29.573 (Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures) of Certification Specification for Large Rotorcraft (CS-29). Note: the European Union Aviation Safety Agency (EASA) considers that tail rotor bearings are part of the scope of CS 29.571/573; or

2. Certification Maintenance Requirements (CMRs) identified when showing compliance with points CS 29.1309 [or equivalent assessments performed when showing compliance with other CS-29 paragraphs such as CS 29.547(b) (Main and tail rotor structure) or CS 29.917(b) (Rotor drive system design)] to ensure that safety objectives are met when addressing significant latent failures (refer to Federal Aviation Administration (FAA) Advisory Circular 29-2C, paragraph 29.1309, which is recognised as Acceptable Means of Compliance (AMC) to CS-29; in addition, details on CMRs are provided in CS-25, AMC 25-19, the content of which is also applied by EASA to CS-29 certification projects through a Means of Compliance Certification Review Item).

Thus, EASA considers that the 'airworthiness status of life limits' of critical parts is ensured by means of demonstrating that the necessary limits are established, when required, in compliance with the Certification Specifications mentioned in points 1 and 2 above.

Following the creation of AMC1 29.571 (addressing rolling contact fatigue) as part of Amendment 11 of CS-29 (ED Decision 2023/001/R), EASA will ensure that bearings installed in rotorcraft certified by EASA comply with CS 29.571 and feature adequate life limits in the ALS, when required.

Safety Recommendation Status	Closed
AAIB Assessment	Adequate
Action Status	Planned Action Completed
Feedback rationale	
The AAIB acknowledges that EASA's response meets the intent of the Safety Recommendation (EU Regulation 996/2010 article 18 refers).	
RESPONSE HISTORY	
Response received: 20 November 2023	
The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.	
AAIB Assessment – Partially Adequate Open	

Safety Recommendation 2023-021

Justification

The duplex bearing was identified as a critical part, as defined by CS 29.602, by the helicopter manufacturer because its failure was assessed as catastrophic, an assessment which has been validated by the circumstances of this accident. Analysis by its manufacturer of the bearing against the development load spectrum has also determined that it would have a finite life in this application, the mitigation for which is replacement before it reaches its anticipated failure life. The airworthiness considerations for non-structural critical parts are identified through assessment to demonstrate compliance with CS 29.602, but this regulation does not currently address life limits or their equivalent status to the ALS limits identified to comply with CS 29.571. As such, no specific rules or guidance are available to manufacturers to provide clarity on this issue.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-021

It is recommended that the European Union Aviation Safety Agency define the airworthiness status of life limits and how they should be controlled for existing non-structural critical parts approved to Certification Specification 29.602 requirements, already in service.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 29 November 2024

In accordance with point 21.A.7 of Annex I (Part 21) to Regulation (EU) No 748/2012, the Type Certificate Holder (TCH) must provide Instructions for Continued Airworthiness (ICA) for critical parts, either structural or non-structural, and, in case of large rotorcraft, the preparation of ICA must be performed in compliance with the Certification Specification (CS) 29.1529.

The ICA applicable to critical parts may be included within the Airworthiness Limitation Section (ALS) of the ICA and/or in other appropriate Sections.

Retirement Times or Operational Time Limits provided in the ICA are necessary for the safe operation of the aircraft and they have to be implemented in the Aircraft Maintenance Programme (AMP) to obtain approval by the Competent Authority [ref. point M.A.302(d)(2) of Annex I (Part M) to Regulation (EU) No 1321/2014]. This requirement is applicable to both ALS and other Sections of the ICA.

In addition, point 21.A.3A of Annex I (Part 21) to Regulation (EU) No 748/2012 contains the necessary provisions for ensuring the collection, investigation and analysis of occurrence reports to identify the necessary mitigations in terms of changes to the design and/or to the ICA to prevent or minimize the possibility of such occurrences in the future, as necessary. This includes, as per point 21.A.3A(a)(1), the identification of adverse trends or deficiencies that cause or might cause adverse effects on the continuing airworthiness of the product. The 'analysis' is not limited to those occurrences that require the involvement of the European Union Aviation Safety Agency (EASA) under point 21.A.3A(e).

Taking into account the information above, the EASA considers that the necessary regulatory framework is already in place and, therefore, EASA does not intend to re-define or re-evaluate the airworthiness status of ICA for critical parts, either structural or non-structural, already in service.

EASA Status: Closed – Disagreement

Safety Recommendation Status **Closed**

AAIB Assessment **Not Adequate**

Action Status **No Planned Actions**

Feedback rationale

The AAIB acknowledges the EASA has reviewed their response as a result of AAIB feedback and has not changed its position on this recommendation (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 22 March 2024

In accordance with point 21.A.7 of Annex I (Part 21) to Regulation (EU) No 748/2012, the Type Certificate Holder (TCH) must provide Instructions for Continued Airworthiness (ICA) for critical parts, either structural or non-structural, and, in case of large rotorcraft, the preparation of ICA must be performed in compliance with the Certification Specification (CS) 29.1529.

The ICA applicable to critical parts may be included within the Airworthiness Limitation Section (ALS) of the ICA and/or in other appropriate Sections.

Retirement Times or Operational Time Limits provided in the ICA are necessary for the safe operation of the aircraft and they have to be implemented in the Aircraft Maintenance Programme (AMP) to obtain approval by the Competent Authority [ref. point M.A.302(d)(2) of Annex I (Part M) to Regulation (EU) No 1321/2014]. This requirement is applicable to both ALS and other Sections of the ICA.

In addition, point 21.A.3A of Annex I (Part 21) to Regulation (EU) No 748/2012 contains the necessary provisions for ensuring the collection, investigation and analysis of occurrence reports to identify the necessary mitigations in terms of changes to the design and/or to the ICA to prevent or minimize the possibility of such occurrences in the future, as necessary. This includes, as per point 21.A.3A(a)(1), the identification of adverse trends or deficiencies that cause or might cause adverse effects on the continuing airworthiness of the product.

The 'analysis' is not limited to those occurrences that require the involvement of the European Union Aviation Safety Agency (EASA) under point 21.A.3A(e).

Taking into account the information above, the EASA considers that the necessary regulatory framework is already in place and, therefore, EASA does not intend to re-define or re-evaluate the airworthiness status of ICA for critical parts, either structural or non-structural, already in service.

EASA Status: Closed - Disagreement

AAIB Assessment – Not Adequate Closed

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if an action is needed toward rotorcraft under EASA responsibility as primary certification authority. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-022

Justification

The classification of the tail rotor duplex bearing as a critical part by the helicopter manufacturer meant that additional control measures were introduced during manufacture and installation of the bearing and required that duplicate and recorded inspections be carried out during maintenance. However, there was no requirement in place to conduct a sample assessment of the bearing condition after removal from service. This could have helped to validate the assumptions used for the calculated L10 life and discard time calculations by flagging up potential premature degradation issues.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-022

It is recommended that the European Union Aviation Safety Agency amend Certification Specification 29.602 to require manufacturers to implement a comprehensive post removal from service assessment programme for critical parts. The findings from this should be used to ensure that reliability and life assumptions in the certification risk analysis for the critical part or the system in which it operates remain valid.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 24 March 2025

The European Union Aviation Safety Agency (EASA) issued Certification Memorandum (CM) CM-S-007 Issue 1 dated 19 August 2015 on 'Post Certification Actions to Verify the Continued Integrity of Rotorcraft Critical Parts'. The purpose of this CM is to supplement the existing guidance for compliance with Certification Specifications CS 27.602 and CS 29.602 (Critical Parts), detailing the need for post-certification actions to verify the continued integrity of Critical Parts. These actions should ensure that critical parts are controlled throughout their service life in order to maintain the critical characteristics on which certification is based. In addition, the effectiveness of any associated design, maintenance and monitoring provisions, which either help to ensure the continued integrity or provide advance indication of impending failure of critical parts, should be assessed.

EASA also addressed this topic under rulemaking task RMT.0128 'Regular update of CS-27&29'. Notice of Proposed Amendment (NPA) 2022-01 was published on 14 February 2022, and is available at <https://www.easa.europa.eu/en/document-library/notices-of-proposed-amendment/npa-2022-01>. Under item 6, this NPA proposed the amendment of CS-27 and CS-29 (certification specifications and acceptable means of compliance for small and large rotorcraft).

The NPA proposed the creation of CS 27.602(c) and CS 29.602(c) and associated acceptable means of compliance AMC1 27.602 and AMC1 29.602 to require the development of a continued integrity verification programme (CIVP). The content of the proposed amendments was based on Certification Memorandum CM-S-007 Issue 1, which is currently used during new type certifications and major changes to existing type certificates.

The CIVP should ensure the continued validity of assumptions made during certification that could affect the integrity of critical parts. This should include, but not be limited to, demonstration of the continuity of the effectiveness of design, maintenance and monitoring provisions (e.g. health monitoring, usage monitoring and safety devices).

However, several comments raised during the public consultation of NPA 2022-01 highlighted a need to clarify the applicability, to promote the proportionality and to better refine the concept of CIVP before its introduction in CS-27 and CS-29. A dedicated webinar was organised on 28 November 2022 to discuss these concerns with industry and National Competent Authorities (NCA). The feedback received was quite positive even if it was clear that the concept needs to be studied further before CIVP is introduced within CS-27 and CS-29.

In consequence, it has been decided that this topic will not be included in the CS-27 and CS-29 amendments resulting from NPA 2022-01.

The CIVP concept has been reviewed by EASA, and a revision of CM-S-007 (Issue 2) has been published for consultation on 16 December 2024. This is available on EASA's website at: <https://www.easa.europa.eu/en/document-library/product-certification-consultations/post-certification-actions-verify-continued>

Issue 2 is intended to provide certain clarifications, in particular:

- The scope of applicability,
- Examples of certification assumptions are provided.

An example of a CIVP plan is provided.

Similarly to the original issue, Issue 2 of this CM addresses the need for post-certification actions to verify the continued integrity of critical parts. These actions should ensure that critical parts are controlled throughout their service life in order to maintain the critical characteristics on which certification is based. In addition, the effectiveness of any associated design, maintenance and monitoring provisions, which either help ensure the continued integrity or provide advance indication of impending failure of critical parts, should be assessed. In addition, this new issue clarifies the scope of parts to be subject to a CIVP, provides further details on the assumptions that may require validation while in service and removes potentially controversial content.

In parallel, EASA planned rulemaking task RMT.0752 entitled 'Continued integrity verification programme (CIVP)' in the European Plan for Aviation Safety (EPAS) Volume II, 2025 edition, which is published at <https://www.easa.europa.eu/en/document-library/general-publications/european-plan-aviation-safety-epas-2025>. This RMT is scheduled to start in Q2 2025. It intends to propose an amendment of CS-27 and CS-29 to introduce the concept and purpose of the CIVP as already contained in CM-S-007 Issue 2, as well as to develop the necessary guidance addressing aspects such as identification of parts to be included within the scope of the CIVP, defining in-service data and activities to be considered in support of CIVP and criteria to identify their need, determining the amount of data needed to support verification of assumptions under the CIVP and ensuring a commensurate approach regarding CS-27 and CS-29 rotorcraft.

The response to this safety recommendation will be updated when progress is made with the above-mentioned actions.

EASA Status: Open

Safety Recommendation Status

Open

AAIB Assessment

Partially Adequate

Action Status

Planned Action Ongoing Update Due 24 December 2025

Feedback rationale

The AAIB acknowledged the response from EASA and requests a further update no later than 24 December 2025. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 06 February 2024

The European Union Aviation Safety Agency (EASA) issued Certification Memorandum (CM) CM-S-007 dated 19 August 2015 on 'Post Certification Actions to Verify the Continued Integrity of Rotorcraft Critical Parts'. The purpose of this CM is to supplement the existing guidance for compliance with Certification Specifications CS 27.602 and CS 29.602 (Critical Parts), detailing the need for post certification actions to verify the continued integrity of Critical Parts. These actions should ensure that critical parts are controlled throughout their service life in order to maintain the critical characteristics on which certification is based. In addition, the effectiveness of any associated design, maintenance and monitoring provisions, which either help to ensure the continued integrity or provide advance indication of impending failure of critical parts, should be assessed.

EASA also addressed this topic under rulemaking task RMT.0128 'Regular update of CS-27&29'. Notice of Proposed Amendment (NPA) 2022-01 was published on 14 February 2022. Under item 6, this NPA proposed to amend CS-27 and CS-29 (certification specifications and acceptable means of compliance for small and large rotorcraft).

The NPA proposed to create CS 27.602(c)/29.602(c) and associated acceptable means of compliance AMC1 27.602/29.602 to require the development of a continued integrity verification programme (CIVP). The content of the proposed amendments was based on CM-S-007, which is currently used during new Type Certifications (TC) and major changes to existing TC.

The CIVP should ensure the continued validity of assumptions made during certification that could affect the integrity of critical parts. This should include, but not be limited to, demonstration of the continuity of the effectiveness of design, maintenance and monitoring provisions (e.g. health monitoring, usage monitoring and safety devices).

However, several comments have been raised during the public consultation of NPA 2022-01 and highlighted a need to clarify the applicability, to promote the proportionality and to better refine the concept of CIVP before its introduction in CS-27 and CS-29. A dedicated webinar was organised on 28 November 2022 to discuss those concerns with industry and National Competent Authorities (NCA). The feedback received was quite positive even if it was clear that the concept needs to be studied further before CIVP is introduced within CS-27 and CS-29.

In consequence, it has been decided that this topic will not be included in the CS-27 and CS-29 amendments resulting from NPA 2022-01.

The CIVP concept is being reviewed by EASA, and a revision of CM-S-007 is being prepared.

In this revision, it is envisaged to clarify that, in case of any findings during the CIVP questioning the validity of the certification assumptions, the applicant should perform a detailed evaluation of the potential impact on flight safety and, when necessary, report to its competent authority for continued airworthiness (EASA and national competent authority). The analysis of a finding in a CIVP could lead to changes to the future certification approach for similar components and/or to continued airworthiness actions.

In parallel, EASA intends to create a new rulemaking task to prepare a new proposal for CS-27 and CS-29 amendment in consultation with the industry.

The response to this safety recommendation will be updated when progress is made with the above-mentioned actions.

AAIB Assessment – Partially Adequate Open

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation, the existing regulatory framework, and other actions recently made on the matter. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-023

Justification

The classification of the tail rotor duplex bearing as a critical part by the helicopter manufacturer meant that additional control measures were introduced during manufacture and installation of the bearing and required that duplicate and recorded inspections be carried out during maintenance. However, there was no requirement in place to conduct a sample assessment of the bearing condition after removal from service. This could have helped to validate the assumptions used for the calculated L10 life and discard time calculations by flagging up potential premature degradation issues.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-023

It is recommended that the European Union Aviation Safety Agency require manufacturers to retrospectively implement a comprehensive post removal from service assessment programme for critical parts, approved to Certification Specification 29.602 requirements, already in service. The findings from this should be used to ensure that the reliability and life assumptions in the certification risk analysis for the critical part or the system in which it operates remain valid.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 29 November 2024

Point 21.A.3A of Annex I (Part 21) to Regulation (EU) No 748/2012 defines the obligations applicable to the Type Certificate Holders (TCHs) to establish and maintain a system for collecting, investigating and analysing occurrence reports. This includes, as per point 21.A.3A(a)(1), identification of adverse trends or deficiencies that might cause adverse effects on the continuing airworthiness of the product.

In addition, acceptable means of compliance AMC1 21.A.3A(a) clarifies that, for parts whose failure could lead to an unsafe condition (and critical parts are candidates as they could have catastrophic effect upon the rotorcraft), the 'analysis' function of the system should ensure that reports and information sent, or available, to the Design Approval Holder (DAH) are fully investigated so that the exact nature of any event and its effect on continuing airworthiness is understood. This may then result in changes to the design and/or to the Instructions for Continued Airworthiness (ICA), and/or in establishing a mitigation plan to prevent or minimize the possibility of such occurrences in the future, as necessary. The 'analysis' is not limited to those occurrences that require the involvement of the European Union Aviation Safety Agency (EASA) under point 21.A.3A(e).

EASA considers that obligations outlined in 21.A.3A already indicate that the TCH shall collect, investigate and analyse reports and information [including the early rejection of parts from service as mentioned in guidance material GM1 21.A.3A(a) and 21.A.3A(b) Reporting system] that might question the certification assumptions for critical parts and when necessary, define design changes and implement mitigation plans.

Therefore, EASA considers that the necessary regulatory framework is already in place to address the intent of this Safety Recommendation (SR) and, therefore, there is no need to retrospectively implement a comprehensive post removal from service assessment programme for critical parts already in service.

EASA Status: Closed – Disagreement

Safety Recommendation Status	Closed
AAIB Assessment	Not Adequate
Action Status	No Planned Actions
Feedback rationale	
<p>The AAIB acknowledges the EASA has reviewed their response as a result of AAIB feedback and has not changed its position on this recommendation (EU Regulation 996/2010 article 18 refers).</p>	
RESPONSE HISTORY	
Response received: 22 March 2024	
<p>Point 21.A.3A of Annex I (Part 21) to Regulation (EU) No 748/2012 defines the obligations applicable to the Type Certificate Holders (TCHs) to establish and maintain a system for collecting, investigating and analysing occurrence reports. This includes, as per point 21.A.3A(a)(1), identification of adverse trends or deficiencies that might cause adverse effects on the continuing airworthiness of the product.</p> <p>In addition, acceptable means of compliance AMC1 21.A.3A(a) clarifies that, for parts whose failure could lead to an unsafe condition (and critical parts are candidates as they could have catastrophic effect upon the rotorcraft), the 'analysis' function of the system should ensure that reports and information sent, or available, to the Design Approval Holder (DAH) are fully investigated so that the exact nature of any event and its effect on continuing airworthiness is understood. This may then result in changes to the design and/or to the Instructions for Continued Airworthiness (ICA), and/or in establishing a mitigation plan to prevent or minimize the possibility of such occurrences in the future, as necessary. The 'analysis' is not limited to those occurrences that require the involvement of the European Union Aviation Safety Agency (EASA) under point 21.A.3A(e).</p> <p>EASA considers that obligations outlined in 21.A.3A already indicate that the TCH shall collect, investigate and analyse reports and information [including the early rejection of parts from service as mentioned in guidance material GM1 21.A.3A(a) and 21.A.3A(b) Reporting system] that might question the certification assumptions for critical parts and when necessary, define design changes and implement mitigation plans.</p> <p>Therefore, EASA considers that the necessary regulatory framework is already in place to address the intent of this Safety Recommendation (SR) and, therefore, there is no need to retrospectively implement a comprehensive post removal from service assessment programme for critical parts already in service.</p>	
EASA Status: Closed - Disagreement	
AAIB Assessment – Not Adequate Closed	
Response received: 20 November 2023	
<p>The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if an action is needed toward rotorcraft under EASA responsibility as primary certification authority. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.</p>	
AAIB Assessment – Partially Adequate Open	

Safety Recommendation 2023-024

Justification

The exposure durations for the load conditions used to calculate the L10 life, and discard time of the bearing, are an approximation using an amalgamated flight profile, combining all the different roles the helicopter can be used for. This produces an estimated percentage of the operating life occurring at the various loads from the maximum to zero. Unlike Chapter Four airworthiness limitations in the AMPI, in practice there is:

- No requirement to operate in accordance with this profile.
- No in-service monitoring of actual operating profiles.
- No penalty life tariff applied to the tail rotor bearings for helicopters which operate for longer at higher loads and contact pressures.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-024

It is recommended that the European Union Aviation Safety Agency amend Certification Specification 29.602 to provide guidance and set minimum standards for the calculation of design load spectrums for non-structural critical parts. They must encompass, with an appropriate and defined safety margin, the highest individual operating load and combination of dynamic operating loads, and the longest duration of exposure to such loads that can be experienced in operation.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 24 March 2025

The accident investigation report mentions a non-conservative loads calculation at the time of certification as a root cause of the bearing failure.

The European Union Aviation Safety Agency (EASA) does not share this single factor conclusion, considering that other possible detrimental factors may also have contributed to the bearing failure.

The methodology for loads calculation as used by Leonardo is not novel or unusual and does not require complete reconsideration by means of new, prescriptive certification specifications.

However, as lessons learned from this accident, EASA considers that future approvals of hybrid bearing with ceramic balls will deserve more attention as regards to the failure mechanics and the sensitivity of the bearing to its working conditions (including abnormal conditions originated by e.g. manufacturing defects, degraded lubrication, improper maintenance, etc..) in order to better cope with a wider range of scenarios.

Consequently, EASA issued Certification Memorandum (CM)-RTS-003 titled 'Hybrid Bearings' on 13 Dec 2024 to provide specific guidance related to the demonstration of compliance with applicable CS-27 and CS-29 certification specifications for hybrid bearings (combination of steel races with ceramic ball bearings). This is available on EASA's website at: <https://www.easa.europa.eu/en/document-library/product-certification-consultations/hybrid-bearings>

EASA considers that this action adequately addresses findings from this accident by highlighting relevant aspects to be addressed during the certification process of rotorcraft featuring hybrid bearings.

EASA Status: Closed – Partial Agreement

Safety Recommendation Status **Closed**

AAIB Assessment **Not Adequate**

Action Status **No Planned Actions**

Feedback rationale

The AAIB report into the accident does not include a non-conservative load calculation as a causal factor in the accident and currently there is no guidance or requirement to calculate loads for non-structural critical parts. The load spectrum calculation for the tail rotor duplex bearing was only produced as the bearing formed part of the tail rotor, a Principal Structural Element.

The methodology used for calculating the loads did not consider the combination of loads combining to increase the surface contact pressure. Additionally, no safety factor was applied to the dynamic loads, which meant there when the in-service dynamic loads were higher than anticipated the loads on the bearing became critical. Safety factors are required when assessing Principal Structural Elements and the AAIB believe that they should also be applied to all critical bearings.

No evidence of manufacturing defects or improper maintenance was identified in the investigation. The degradation of the grease was a result of the higher loads leading to sliding not rolling.

EASA issued Certification Memorandum (CM)-RTS-003 quotes EASA CS 29-571 with related to rolling contact fatigue in Principal Structural Elements which would not include the tail rotor duplex bearing. The document focuses on the inherent issues with ceramic bearings, not the application of the bearings within a system and more specifically there is no mention of the calculation of load spectrums or safety factors when selecting a bearing. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 06 February 2024

The accident investigation report mentions a non-conservative load calculation at the time of certification as a potential root cause of the bearing failure.

The European Union Aviation Safety Agency (EASA) does not share this single factor conclusion, considering that other possible detrimental factors might also have contributed to the bearing failure, as already explained in comments appended to the final investigation report as Appendix K, published here: [AAR_1-2023_G-VSKP_Final_Vol_2.pdf](#) (publishing.service.gov.uk)

The methodology for load calculation as used by Leonardo is not novel or unusual and does not require complete reconsideration by new prescriptive certification specifications.

However, as lessons learnt from this accident, EASA considers that future approvals of hybrid bearing with ceramic balls will deserve more attention as regards to the failure mechanics and the sensitivity of the bearing to its working conditions (including abnormal conditions created by e.g. manufacturing defects, degraded lubrication, improper maintenance, etc.,) in order to better cope with a wider range of scenarios.

EASA plans to issue a Certification Memorandum (CM) to provide specific guidance related to the demonstration of compliance with applicable CS-27 and CS-29 certification specifications for hybrid bearings (combination of steel races with ceramic ball bearings).

The response to this safety recommendation will be updated when the CM is issued.

AAIB Assessment – Partially Adequate Open

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open

Safety Recommendation 2023-025

Justification

Amend Certification Specification 29 to ensure that where catastrophic failure modes are identified, practical mitigation methods within the wider system should be reviewed in order to mitigate the severity of the outcome as well as the likelihood of occurrence.

Therefore, the following safety recommendation was made:

Safety Recommendation 2023-025

It is recommended that the European Union Aviation Safety Agency amend the relevant requirements of Certification Specification 29 and their Acceptable Means of Compliance to emphasise that where potentially catastrophic failure modes are identified, rather than rely solely on statistical analysis to address the risk, the wider system should also be reviewed for practical mitigation options, such as early warning systems and failure tolerant design, in order to mitigate the severity of the outcome as well as the likelihood of occurrence.

Date Safety Recommendation made: 25 August 2023

LATEST RESPONSE

Response received: 19 July 2024

The European Union Aviation Safety Agency (EASA) considers that practical mitigation options such as early warning systems and failure tolerant designs are relevant means to achieve adequate safety levels in rotorcraft designs.

According to CS-29 Amdt 11 (Certification Specifications, Acceptable Means of Compliance (AMC) and Guidance Material for Large Rotorcraft), CS 29.571 (Fatigue tolerance evaluation of metallic structure) and AMC1 29.571 (dealing with rolling contact fatigue (RCF)) address the need to take into account the impact of RCF and minimise the risk of crack initiation resulting from RCF on Principal Structural Elements (PSEs). In addition, AMC1 29.571 states that 'as it is difficult to totally preclude cracking initiated by RCF, a fail-safe approach is recommended wherever possible, such that cracking of the affected structural element(s) is detected prior to its residual strength capability falling below the required levels prescribed in CS 29.571(f)'. Hence AMC1 29.571 clearly introduces the notion of fail-safe designs and of means of detection to fulfil the objective of preventing failure as a result of RCF. This regulatory material was relatively new at the date of publication of the accident investigation report and it appeared, in EASA's view, not to have been considered.

Nevertheless, additional CS-29 provisions help to meet the intent of this safety recommendation:

(1) The design assessments specified by CS 29.547(b) (Strength requirements - Main and tail rotor structure) and CS 29.917(b) (Powerplant – Rotor Drive System - Design) require the identification of all failures in rotors and rotor drive systems that will prevent continued safe flight or safe landing, as well as the means to minimise the likelihood of their occurrence. As per Federal Aviation Administration (FAA) Advisory Circular

(AC) 29-2C Change 7 (recognised as AMC to CS-29) sections 29.547 and 29.917, 'a design assessment [...] should be carried out in order to substantiate that the system is of a safe design and that compensating provisions are made available to prevent failures classified as hazardous and catastrophic[...]'. The listed compensating provisions include design features (such as redundancies and safety factors) and the use of safety devices or vibration health monitoring systems, which cover the means proposed by the AAIB in this safety recommendation.

Other compensating provisions such as inspections or checks, as well as preventive maintenance are also listed.

(2) Since some years EASA has recognised the need to clearly identify those continuing airworthiness tasks which are listed as compensating provisions in the aforementioned design assessments and are also considered key to ensuring that the hazardous and catastrophic failures of the design are either adequately mitigated or their probability of occurrence has been adequately minimised. EASA considers that these continuing airworthiness tasks should be:

(i) considered as candidates for Certification Maintenance Requirements (CMRs) in accordance with AMC 25-19 of CS-25 (Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes). EASA currently addresses the application of the CS-25 CMR concept to support the demonstration of compliance with large rotorcraft certification specifications requiring safety assessment and design assessment, including CS 29.547(b) and CS 29.917(b), through a Means of Compliance Certification Review Item. Therein applicants are requested to detail the criteria and methods to demonstrate the adequacy of these CMRs.

(ii) evaluated for the need of dedicated certification testing to demonstrate adequate performance and suitable intervals. EASA is currently considering the possibility of introducing new AMC to CS 29.927(a) (Additional tests) to address this aspect. This would clarify the need to support inspection intervals and retirement times with appropriate directly applicable data.

In conclusion, while the relevance of a full assessment of the design and a detailed evaluation of the failure scenarios is agreed and already present in CS-29, EASA considers that mandating design measures to systematically mitigate the outcome of catastrophic failures could be counterproductive. This could lead to impractical and overly complex solutions, that negatively impact the reliability of rotors and rotor drive systems.

Based on the above, EASA considers that the necessary elements are in place to ensure that hazardous and catastrophic failures are adequately addressed during certification, by adequately mitigating such failures and/or minimising their probability of occurrence, thus, ensuring adequate safety levels.

Safety Recommendation Status

Closed

AAIB Assessment

Not Adequate

Action Status

No Planned Actions

Feedback rationale

The changes to CS 29.571 were introduced to address issues within Principal Structural Elements (PSE). The rotor control system is not a PSE and is not certified to CS 29.571. This is stated in the AAIB report and the preamble to this Safety Recommendation.

The Acceptable Means of Compliance (AMC) for CS 29.547 do not quote FAA AC 29-2C. FAA AC 29-2C is considered explicitly as part of the AMC for other regulations. This has not changed with the publication of change 7 to AC 29-2C amendment 11 of CS-29 being issued in 2023. As such, there is nothing to direct manufacturers to consider it for compliance with this regulation.

CS 29.917 does not have a bearing on this Safety Recommendation as it relates to the rotor drive system not the rotor control system.

As stated in the report there were no Certification Maintenance Requirements (CMR) on the tail rotor control system, even though this process was in place at the time of certification of the AW169 and AC 25-19 was published in 2011.

There is no change to the requirement for dedicated testing of the tail rotor control system since the accident, which is still only considered by the regulations as part of the overall helicopter operation.

As stated in the AAIB's report, once a failure mode is considered catastrophic no further assessment is required. The response to this Safety Recommendation does not change that position. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 06 February 2024

The European Union Aviation Safety Agency (EASA) considers that some steps have already been taken to ensure a more comprehensive evaluation of critical bearings installed in the rotor and rotor drive systems.

For instance, Certification Specification CS 29.571 (Fatigue tolerance evaluation of metallic structure) and Acceptable Means of Compliance AMC1 29.571 (dealing with rolling contact fatigue (RCF)) address the need to take into account the impact of RCF and minimise the risk of crack initiation resulting from RCF on Principal Structural Elements (PSEs). In addition, AMC1 29.571 states that 'as it is difficult to totally preclude cracking initiated by RCF, a fail-safe approach is recommended wherever possible, such that cracking of the affected structural element(s) is detected prior to its residual strength capability falling below the required levels prescribed in CS 29.571(f)'.

No further change to CS-29 is planned on this topic.

AAIB Assessment – Not Adequate Open

Response received: 20 November 2023

The European Union Aviation Safety Agency (EASA) is reviewing the proposal contained in this safety recommendation and the existing regulatory framework. EASA will then decide if a rulemaking or other action is needed. This response will be updated as soon as an orientation is decided on this matter, which is anticipated to happen by Q1 2024.

AAIB Assessment – Partially Adequate Open