

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250 ft, the pilot began the transition to forward flight by pitching the helicopter nosedown and the landing gear was retracted.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.

The investigation found the following causal factors for this accident:

1. Seizure of the tail rotor duplex bearing initiated a sequence of failures in the tail rotor pitch control mechanism which culminated in the unrecoverable loss of control of the tail rotor blade pitch angle and the blades moving to their physical limit of travel.
2. The unopposed main rotor torque couple and negative tail rotor blade pitch angle resulted in an increasing rate of rotation of the helicopter in yaw, which induced pitch and roll deviations and made effective control of the helicopter's flightpath impossible.
3. The tail rotor duplex bearing likely experienced a combination of dynamic axial and bending moment loads which generated internal contact pressures sufficient to result in lubrication breakdown and the balls sliding across the race surface. This caused premature, surface initiated rolling contact fatigue damage to accumulate until the

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024.

RESPONSE HISTORY

N/A

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: 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.

Safety Recommendation Status Open

AAIB Assessment Partially Adequate

Action Status Not Enough Information

Feedback rationale

The AAIB recognises the planned review by the EASA in Q1 2024 and requests an update by 03 June 2024

RESPONSE HISTORY

N/A