Bell 407, N120HH	**Long Marston, Stratford-upon-Avon, Warwickshire**	**24 June 2020**	**Accident**

Investigation Synopsis

The pilot and passenger were returning to Thruxton Aerodrome following a short flight over the Malvern hills when the engine failed. The pilot executed an autorotation landing in a field near Long Marston, after which they were both able to exit the helicopter without injury. However, the tail boom was severed during the landing and the helicopter was destroyed by fire.The investigation found that the engine suffered an uncontained failure of the gas producing turbine disc due to insufficient oil reaching the bearings as a result of an oil leak. Due to the extensive damage to the helicopter it was not possible to determine the cause of the oil leak. Two Safety Recommendations were made regarding the Failure Mode and Effects Analysis for the engine, and the fire resistance and crashworthiness of aircraft components. The helicopter manufacturer undertook two Safety Actions regarding advice to pilots, and one Safety Action regarding analysis of the airframe fuel filter.

Safety Recommendation 2021-047

Justification

The accident sequence has shown that a loss of oil can lead to a burst of the GP2 rotor, the debris of which would not have been attenuated by the energy absorbing ring. Because the axial movement of the GP turbine is outside of the Rolls Royce design intent and certification criteria, the Failure Modes and Effects Analysis for the engine may not fully capture the linkage between loss of engine oil and uncontained bursting of the GP2 rotor.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2021-047**
>
> It is recommended that Rolls-Royce Corporation includes the scenario of a loss of engine oil leading to the uncontained failure of both Gas Producer Turbine Discs in the Failure Mode and Effects Analysis for the Rolls-Royce M250 Series 4 engines.

Date Safety Recommendation made: 23 September 2021

LATEST RESPONSE

Response received: 29 November 2021

The M250-C47B FMECA was reviewed by Rolls Royce and found to contain two entries for insufficient oil supply to the No. 8 bearing; one which properly described the potential for T2 wheel burst and one with the highest level effect being in-flight shutdown. This FMECA was revised to eliminate the duplicate entry, maintaining the line with the proper description (i.e. T2 wheel burst). Additionally, the M250 Series IV Baseline FMECA was also reviewed and found to only describe in-flight shutdown as the highest level effect of insufficient oil supply to the No. 8 bearing. This FMECA was also revised to properly describe the potential for T2 wheel burst. These FMECAs have now been formally updated within Rolls-Royce and are live documents."

Safety Recommendation Status	**Closed**
AAIB Assessment	**Adequate**
Action Status	**Planned Action Completed**

RESPONSE HISTORY

N/A

Safety Recommendation 2021-048

Justification

The guidance for 14 CFR Part 27 does not appear to clearly articulate the need for components to be able to meet their crashworthiness requirements after exposure to fire and heat.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2021-048**
>
> It is recommended that Transport Canada assess its guidance material for 14 CFR Part 27 and Part 33 requirements on fire resistance and crashworthiness such that fuel system components certified to be fire resistant also retain sufficient residual material integrity to meet their crashworthiness requirements.

Date Safety Recommendation made: 23 September 2021

LATEST RESPONSE

Response received: 18 October 2021

The conditions for fire resistance are addressed in the FAR part 1.1 definition, AC 20-135 Change 1 and AC 33.17-1A. Per FAA AC 33.17-1A, the intent of shielding per FAR 33.17(b) may be applied to engine fuel system components to minimize the possibility of leaking flammable fluid and also retain sufficient residual material integrity to meet their crashworthiness requirements in a fire situation. The fire resistant criteria has been applied to engine fuel system components because the 5 minute exposure provides a reasonable time period for the flight crew to recognize a fire condition, close the appropriate fuel shutoff valve(s), and shutdown the engine, thereby cutting off the fuel source. At the aircraft level, per FAR 27.1183(a), fuel system components may have a fireproof shield or be located so as to safeguard against the ignition of leaking flammable fluid. The partial text of FAR 33.17(b) and 27.1183(a) read similar.

Per FAA AC 21-16G, the FAA encourages the use of RTCA DO-160 Environmental Conditions and Test Procedures for Airborne Equipment as one acceptable document for environmental qualifications to show compliance with certain airworthiness requirements. Specifically, DO-160 Section 7.0Operational Shocks and Crash Safety contains requirements for a crash safety test of components to make sure they will not detach during an emergency landing. Aircraft fuel system components within the engine area (powerplant installation) may be subject to such DO-160 test and also to FAR 27.952 requirements, which considered the recommendations of report NTSB-AAS-80-2. The FAR section 27.952 is not specific to powerplant installation fuel components but it may be made to apply because, for example, a fuel filter located in the engine area, is an airframe mounted fuel system component. For future certification programs, TC and an Applicant may agree on a means to improve powerplant installation fuel components' crashworthiness.

The FAA AC 27-1B contains acceptable methods of compliance to each relevant FAR section 27.XXXX and are provided to guide the Applicant on how to retain sufficient residual material integrity to meet the crashworthiness requirements. During a certification program, a detailed review of the design is conducted to identify and quantify all fuel system components in areas subject to engine fire conditions such as engine compartments and other fire zones. Once these items are identified, the design means of fire protection and residual material integrity are selected and validated, as necessary, during the certification process and agreed by TC.

For components that cannot be qualified as fire resistant by similarity or by known material standards, testing to severe fire conditions (see paragraph AC 27.859 definition and AC 20-135 for detailed requirements) are conducted on full-scale specimens or representative samples to establish their fire resistance capabilities and sufficient residual material integrity.

Transport Canada supports the TSB/AAIB Safety Recommendation 2021-048 objective of reducing post landing fires in small helicopters. TC has used the above FAA AC's as acceptable means of compliance in its regulatory system and deems that the current FAR standards in Table 1 (which are harmonized with Airworthiness Manual (AWM) Chapters 527 and 533) and means of compliance are sufficient to address the safety recommendation. TC will continue to monitor post landing fire events as part of on-going certification work. TC has no further activities planned at this time, is satisfied with measures taken and suggests this safety recommendation be closed.

Safety Recommendation Status	**Closed**
AAIB Assessment	**Adequate**
Action Status	**Planned Action Completed**

RESPONSE HISTORY

N/A