

Follow-up Action on Occurrence Report

ACCIDENT TO SIKORSKY S61N, G-BBHM, AT POOLE, DORSET ON 15 JULY 2002
(HELICOPTER FORCE LANDED AND BURNT OUT AFTER ENGINE FIRE WARNINGS)

CAA FACTOR NUMBER : F21/2004
FACTOR PUBLICATION DATE : 16 April 2004
OPERATOR : Bristow Helicopters Ltd
CAA OCCURRENCE NUMBER : 2002/04849
AAIB REPORT : AAR 2/2004

SYNOPSIS

(From AAIB Report)

G-BBHM, which was based at Portland, was being operated in the Search and Rescue role. Following the first alert of the day, G-BBHM had been airborne for about 40 minutes over Poole Harbour when the two rear crew members became aware of an unusual noise. Almost immediately, the pilots saw the 'NO 2 ENG FIRE WARN' light illuminate accompanied by the audio alert. The pilots commenced their emergency procedures, including shutting down the No 2 engine and activating the fire extinguisher, and initially set heading for Bournemouth Airport. However, with the 'FIRE' light still illuminated and indications of hydraulic failures from both tactile and warning systems, the co-pilot alerted the commander to a suitable nearby landing area. The commander called for an immediate landing and made a successful approach and touchdown; during the approach, the pilots became aware that 'NO 1 ENG FIRE WARN' was also illuminated. After touchdown, the pilots shut down No 1 engine and the crew quickly vacated the helicopter. G-BBHM was destroyed by fire shortly after they were clear. The time between the onset of the original fire warning and touchdown was 82 seconds.

The investigation identified the following causal factors:

1. The No 2 engine had suffered rapid deterioration of the No 5 (location) bearing of the free turbine, causing failure of the adjacent carbon oil seal and mechanical interference between the Main Drive Shaft Thomas coupling and the Engine Mounting Rear Support Assembly tube, which completely severed the support tube.
2. A severe fire, outside of the engine fire zone, was caused because the released engine oil was ignited either by this mechanical interference, or by contact with the hot engine exhaust duct.
3. The No 2 engine's No 5 bearing failed because of unusual and excessive cyclic loading conditions arising from shaft vibration. The bearing deterioration was exacerbated by a reduction in its oil supply during the same period, when the live oil jet fractured as a consequence of the vibration.
4. It is probable that the Main Drive Shaft vibration was caused by damage or distortion sustained during one or more previous No 2 engine starts involving a high torque rotor engagement.
5. There was no specific torque limitation published in the manufacturer's Flight Manual, used by Bristow Helicopters Limited, during rotor engagement after engine start.

FOLLOW UP ACTION

The thirteen Safety Recommendations, made by the AAIB following their investigation, are reproduced below, together with the CAA's responses.

Recommendation 2002-51

The US Federal Aviation Administration, in conjunction with UK CAA and the airframe and engine manufacturers, implement a means of providing a suitable warning to aircrew and/or engineering staff, of any impending loss of integrity of the drive shaft system of the S61N helicopter which could lead to failure of the engine rear support mounting tube.

CAA Response

The CAA accepts this Recommendation.

In accordance with standard practice the CAA stands ready to support the US Federal Aviation Administration and the airframe and engine manufacturers to implement a means to provide a suitable warning to aircrew of any impending loss of integrity of the drive shaft system of the S61N helicopter which could lead to failure of the engine rear support mounting tube. In the meantime, in order to address one possible source which could lead to failure of the engine rear support mounting tube, the CAA UK issued Additional Airworthiness Directive (AAD) number 002-12-2002 on the 17th December 2002. This AAD requires UK operators of S61N helicopters, by the 31st January 2003, both to install electrical chip detectors (ECDs) on each engine's power turbine accessory drive, and to modify the aircraft to enable monitoring of these ECDs to be conducted by means of in situ continuity checks by engineering staff after each engine shutdown.

Note: This Response was sent to the AAIB on 12 February 2003.

CAA Status - Open

Recommendation 2002-52

The US Federal Aviation Administration, in conjunction with UK CAA and the airframe manufacturer, ensure that the integrity of the engine fire zones on the S61N helicopter is not breached by a failure of the engine rear support mounting tube.

CAA Response

The CAA accepts this Recommendation.

In accordance with standard practice the CAA stands ready to support the US Federal Aviation Administration and the airframe manufacturer in developing any airworthiness measures that are deemed necessary to ensure safe operation of the S61N helicopter. To that end, on 13 November 2002, CAA wrote formally to the US Federal Aviation Administration and the airframe manufacturer with a request for consideration of appropriate actions that may be necessary to meet the intent of this Recommendation.

Note: This Response was sent to the AAIB on 12 February 2003.

CAA Status - Closed

Recommendation 2002-53

The US Federal Aviation Administration, in conjunction with UK CAA and the airframe manufacturer, devise a means of protecting essential systems in the main rotor gearbox bay of the S61N helicopter from the effects of fire.

CAA Response

The CAA does not accept this Recommendation.

The current design requirements for fire protection of essential systems, as contained within JAR 29.1191, have given, over many years, a satisfactory level of safety for large helicopters of all types. These requirements specify that essential systems need be fireproof only in cases where they are not isolated from potential powerplant fires by a firewall shroud. In that respect, assurance of the integrity of the engine fire zones has been covered by the CAA response to Recommendation 2002-52.

Note: This Response was sent to the AAIB on 12 February 2003.

CAA Status - Closed

Recommendation 2003-83

The aircraft manufacturer, Sikorsky, should relocate the No 1 and No 2 engine bay fire warning lights on the main instrument panel of the S-61N helicopter, with the intention of ensuring as far as possible that unambiguous information is presented to both flight crew members in the event of an engine bay fire.

CAA Response

This Recommendation is not addressed to the CAA.

CAA Status - Closed

Recommendation 2003-84

The FAA, CAA, and engine manufacturer should introduce a modification to the oil jet assembly that, in the event of fracture of the tube which supplies oil to the carbon seal, would prevent a large reduction in supply pressure to the nozzle which supplies oil to the No 5 bearing.

CAA Response

The CAA does not accept this Recommendation.

The Accident report states clearly that failure of the oil tube was not the primary cause of the No 5 bearing deterioration.

In view of the report's conclusion, the CAA believes that action focussed upon preventing fractures of this oil tube would be preferable and would support any design activity undertaken by the manufacturer and the FAA to this effect.

CAA Status - Closed

Recommendation 2003-85

The CAA, together with the FAA, airframe and engine manufacturers, should consider the possible value of measuring short term variability in the recorded NF speed on S-61 helicopter engines, in order to provide early warning of loss of integrity of the drive shaft system, which could lead to failure of the engine mounting rear support assembly tube and subsequent fire.

CAA Response

The CAA does not accept this recommendation.

The Accident report acknowledges that the Nf speed variation increased during the final hour of flight. The CAA however, does not agree that a 'noticeable change could be observed at this time. The report also acknowledges that such speed fluctuations are inherently variable and that, consequently, an early warning by this means may be neither reliable nor adequate.

In addition, the CAA considers that the timely introduction of a practicable warning means has been provided through the action already taken in addressing recommendation 2003-51.

CAA Status - Closed

Recommendation 2003-86

The FAA and CAA should require Flight Manuals for all variants of the S-61 and similar types to include an appropriate torque limitation during rotor engagement.

CAA Response

The CAA accepts this recommendation. In accordance with standard practice the CAA will support the FAA and the manufacturer in introducing appropriate torque limitations to the Flight Manual.

CAA Status - Closed

Recommendation 2003-87

The FAA and CAA, together with the airframe and engine manufacturers, should investigate the dynamic behaviour of the S-61 MDS and associated high speed rotating components in support of the introduction of an appropriate torque limitation during rotor engagement.

CAA Response

The CAA does not accept this recommendation.

The results of the analytical MDS dynamic analysis undertaken during the course of this investigation contradict those of comprehensive tests and analyses undertaken previously by the aircraft manufacturer. The results of the manufacturer's work do not support the need for torque limitations to be imposed as a result of any dynamic behaviour of the S-61 MDS.

The manufacturer has accepted that there is a potential for damage to the No. 5 bearing of the engine to occur as a result of high torque during rotor engagement and it is for this reason that appropriate torque limits are being established.

It is considered that the manufacturer's proposed action to introduce engine torque limitations during rotor engagement (Refer to Recommendation 2003-86) within the Flight Manual addresses this Recommendation.

CAA Status - Closed

Recommendation 2003-88

The CAA, in conjunction with the HUMS systems designers, should require the incorporation into future software versions the capability of providing, automatically, appropriate information about the recorded parameters and the integrity and completeness of the data.

CAA Response

The CAA partially accepts this Recommendation.

Failure fully to acquire HUMS data during a single flight is in itself not a safety concern as the HUMS is intended to identify trends and thereby anticipate those failures that could escalate to a potentially Hazardous condition over a number of flights.

Nevertheless, the CAA recognises the potential for benefits to be realised through more robust HUMS designs that may result from action taken to address this Recommendation. Therefore, whilst not requiring the implementation of such means in future software at this stage, the CAA will review the need for a capability to provide, automatically, appropriate information about the recorded parameters and the integrity and completeness of the data. This review will be undertaken in conjunction with HUMS designers and operators and will be completed by December 2005.

CAA Status - Open

Recommendation 2003-89

The CAA should require, for operations where HUMS is expected to contribute to the safe operation of the aircraft, improved training for the engineering staff to facilitate useful and meaningful 'first level' interrogation and investigation of the data.

CAA Response

The CAA partially accepts this Recommendation.

Insufficient training for engineering staff in the use of HUMS is not identified within the investigation report as a contributing factor in this incident. Furthermore, the CAA is not aware of any other data that indicate that current training requirements are inadequate.

The CAA, when making HUMS mandatory, issued CAP 693 which provides acceptable means of compliance for the implementation and operation of HUMS. This document describes the necessary skills required by staff and the associated training. Both the CAA and the aircraft operators carry out routine audits of HUMS that include checks of staff training.

CAP 693 will be updated to take account of latest regulatory developments for HUMS. During the course of this revision all aspects of the document, including initial and continuation training for HUMS, will be checked and enhanced where appropriate in accordance with the CAA's policy of continuous improvement.

CAA Status - Closed

Recommendation 2003-90

The CAA, together with HUMS system designers, should incorporate in future HUMS software versions, algorithms which can identify changing signal parameters, other than levels, such as frequency changes and the development of harmonics.

CAA Response

The CAA partially accepts this Recommendation.

The investigation report does not suggest either that the HUMS data or its interpretation was flawed, and contributed in any way to this incident.

The service experience to date indicates that HUMS are approximately 69% effective at detecting incipient failure modes. The CAA considers that with further design enhancements this figure may increase to 80% and beyond. The CAA has therefore invited tenders for the research and development of neural networks and associated algorithms that will contribute towards the achievement of this goal. The results of this research will be used to help inform a decision on the need for algorithms which can identify changing signal parameters, other than levels, such as frequency changes and the development of harmonics.

This research is expected to commence in 2004 and to be completed by July 2006.

Recommendation 2003-91

It is recommended that the CAA, together with HUMS systems designers, should incorporate in future HUMS requirements, a requirement for a suitable infrastructure to facilitate the comparison of stored HUMS data between aircraft.

CAA Response

The CAA partially accepts this Recommendation.

The investigation report does not suggest either that the HUMS data or its interpretation was flawed, and contributed in any way to this incident.

Nevertheless, the CAA recognises the potential for benefits to be realised through comparison of stored data. The CAA will therefore include this subject within a review undertaken in conjunction with HUMS designers and operators that will be completed by December 2005. The results of this review will be used to help inform a decision on the need for a requirement for an infrastructure to facilitate the comparison of data.

CAA Status - Open

Recommendation 2003-92

The CAA, in conjunction with HUMS system designers, should consider in future design, the incorporation of modified DAPUs which provide an indication of the completion of the data acquisition cycle.

CAA Response

The CAA accepts this Recommendation.

The investigation report does not identify incomplete HUMS data acquisition as a contributory factor in this incident.

Nevertheless, the CAA recognises the potential for benefits to be realised through more robust HUMS designs that may result from action taken to address this Recommendation. Therefore, the CAA will consider for future designs the incorporation of modified DAPUs that provide an indication of the completion of the data acquisition cycle. This will be included in a review undertaken in conjunction with HUMS designers and operators that will be completed by December 2005.

In the meantime, it has been confirmed that SAR operational procedures are in place that ensure complete in-flight data collection. These procedures include a safeguard to ensure that when a failure to acquire a full data set is detected, an additional "rotors running" data acquisition is required.

CAA Status - Open