

AVIATION OCCURRENCE REPORT

A98P0156

TAIL ROTOR PITCH LINK FAILURE

HELIJET AIRWAYS INC.

SIKORSKY S-76A (HELICOPTER) C-GHJL

VANCOUVER, BRITISH COLUMBIA

17 JUNE 1998

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

The Sikorsky S-76A helicopter, serial number 760214, departed Vancouver Harbor helipad at about 1238 Pacific daylight time (PDT) with two pilots and eight passengers on board for a flight to the Vancouver International Airport. When the pilot decelerated for landing, he experienced a high-frequency vibration in the collective pitch lever. He continued the approach using the minimum power required and noted that the intensity of the vibrations was reduced. During the final phase of the approach, the pilot noticed low intensity vibrations in the tail rotor pedals. He carried out a no-hover landing and taxied to the hangar without further incident. There were no injuries or damage.

Ce rapport est également disponible en français.

Other Factual Information

Company maintenance personnel determined that the vibrations were the result of a broken tail rotor pitch control rod assembly (Sikorsky part number 76103-05003-041, serial number A063-00899). The broken pitch control rod assembly was removed and forwarded to the TSB Engineering Branch for inspection and analysis.

The tail rotor pitch control rod assembly consists of a link and two rod end assemblies. The rod end assemblies, each consisting of a rod end and a bearing, are threaded into the ends of the link and are retained in place by a nut and locking device. Following installation on the helicopter, the tail rotor pitch control rod assemblies are maintained as "on condition" units and are not required to be removed or overhauled in accordance with any specified time frame.

Item 8 in the 50-hour inspection checklist, detailed in maintenance manual SA 4047-76-2-1, Dec.98, Chapter 5-20-00, states "Tail rotor pitch control rods and pitch beam for damage and security. Rod end bearings for condition." There is also no requirement to track the part's service history. The broken component of the pitch control rod assembly was the rod end (Sikorsky part number 76103-05002-102), and it was found broken adjacent to the nut.

The Sikorsky S-76A four-bladed tail rotor consists of two opposing blade pairs, joined at the hub, constituting an "inner" pair and an "outer" pair. The pitch control rod assemblies for each of the two pairs are identical, except that the assemblies connected to the inner blade pair are longer than those connected to the outer blade pair. This length differential is achieved by adjustment of the rod ends.

The rod end assemblies are the subject of Sikorsky Alert Service Bulletin (ASB) 76-65-45, first issued 11 March 1994 and reissued 08 June 1994 as ASB 76-65-45A. The *Canadian Aviation Regulations* (CARs) do not require operators to comply with a manufacturer's bulletins. Neither the U.S. Federal Aviation Authority, who oversees the S-76 design, nor Transport Canada has issued an Airworthiness Directive in relation to this Service Bulletin. The purpose of Sikorsky ASB 76-65-45 and 76-65-45A is to perform a one-time inspection of the tail rotor control rod assemblies for cracks in the exposed threaded areas of the rod ends. A visual inspection is to be performed for cracks and corrosion pits using a 10X power magnifying glass. If no crack indication or corrosion pits are found, a fluorescent penetrant inspection is to be performed on the exposed threaded areas on both rod ends of the four control rod assemblies to determine if a crack is present. If a crack indication or corrosion pits are found, the rod end is to be replaced.

Sikorsky ASB 76-65-45 and 76-65-45A inspections are specific to the rod ends (Sikorsky part number 76103-05002-102 and 76103-05002-101) and not to the helicopter. The ASB requires, upon accomplishment of the instructions, an appropriate logbook entry be made to show compliance with this ASB. HeliJet Airways Inc. recorded compliance with Sikorsky ASB 76-65-45 on the incident helicopter on 14 May 1994 with an accumulated airframe time of 14 940 hours total time since new (TTSN). At the time of the pitch control rod assembly removal, the helicopter had accumulated 21 412 hours TTSN. The pitch control rod assembly failed after 6472 hours, and about four years and one month after the Sikorsky ASB 76-65-45 had been complied with. HeliJet Airways Inc. did not have a record of the TTSN for the pitch control rod assembly, nor were they required to.

With respect to detecting cracks in the tail rotor pitch control rod ends, the Sikorsky S-76 approved

Maintenance Manual (Revision 31) does not specify an inspection, nor does it contain details as to how to perform such an inspection. The Maintenance Manual does, however, identify the need to inspect the pitch control rod assemblies for corrosion, but only on the exposed threads of the rod ends, and only if the protective paint /corrosion preventive compound has been degraded. The Maintenance Manual details the inspection procedures for the pitch control rod and damper bearings and identifies corrosion prevention procedures for the tail rotor pitch control rods including the rod end threaded area.

The mode of failure was determined to be high cycle fatigue; the fracture propagated under normal service loads from fatigue-generated pre-cracks originating from the region of the thread root, close to the corners of the keyway. The crack initiated in the first full thread outboard of the bearing housing, an area that is exposed. Fatigue was found to be coincident with the stress concentration provided by the thread roots in the presence of corrosion pitting. Similar failures have been recorded by Sikorsky.

The TSB Engineering Branch report states the tail rotor pitch control rod bearing radial play was found to be within Sikorsky's published limits; however, the metal-to-metal contact between the inner and outer bearing races appears to meet the Maintenance Manual requirement for replacement of the rod end. The TSB Engineering Branch report also states that the exposed threaded portions of the broken tail rotor pitch control rod did not have the required corrosion-preventative compounds applied. No traces of paint or other surface protection materials were detected.

Analysis

A rod assembly installed on an inner blade requires the rod ends to be adjusted so that there are more exposed threads than what would be found on a rod assembly used on an outer blade. If a rod assembly—specifically a rod end that was previously used on an inner blade—was reinstalled on an outer blade, the need to thread the rod end further into the link could result in a crack being hidden by the link, the locking devise, or the nut. Because the inspections in the Sikorsky S-76 Maintenance Manual (Revision 31) and in ASB 76-65-45A are specific to only the exposed threaded area of the rod end, it is possible that a such a crack could be hidden. Furthermore, since the Maintenance Manual does not specify a requirement to check for cracks in the tail rotor pitch control rod assembly rod ends, it is possible that a crack could remain undetected.

A logbook entry must be made showing compliance with Sikorsky ASB 76-65-45A. However, if a rod assembly or rod end were changed, and no service history on the part was available (including whether the ASB inspection had been performed on the part), the aircraft records could show compliance with the ASB although the rod end could be cracked. If an inspection (as defined in the ASB) were not performed, such a crack could remain undetected.

The ASB details a procedure for positively identifying cracks. The Maintenance Manual requirements—to check for damage and security—are general in nature, and do not include instructions on how to perform a crack inspection. Without a specific requirement to check for cracks, including instructions on how to perform such an inspection, it is likely the operator will perform a general inspection, which will not produce the same results as required in the ASB.

The following Engineering Branch report was completed:

LP 81/98 T/R Pitch Link Assembly

Findings

1. The rod end (part number 76103-05002-102) failed as a result of high cycle fatigue under normal service loads. Fatigue was found to be coincident with the stress concentration provided by the thread roots in the presence of corrosion pitting.
2. The exact TTSN and service history of the rod end could not be determined.
3. The tail rotor pitch control rod assemblies are maintained as an “on condition” item.
4. The integrity of the rod end cannot be accurately determined unless the entire threaded area is inspected.
5. Sikorsky Alert Service Bulletin 76-65-45, first issued 11 March 1994 and reissued 8 June 1994 as 76-65-45A, highly recommends an inspection be performed on the exposed threaded areas of the rod ends.
6. The inspection requirements of Sikorsky ASB 76-65-45 and ASB 76-65-45A are specific to the rod ends; however, the documentation showing compliance is specific to the helicopter records.
7. The Sikorsky S-76 Maintenance Manual (Revision 31) does not identify a unique requirement to inspect the tail rotor pitch control rod assembly rod ends for cracks.
8. The tail rotor pitch control rod bearing radial play was found to be within Sikorsky’s published limits; however, the metal-to-metal contact between the inner and outer bearing races appears to meet the Maintenance Manual requirement for replacement of the rod end.
9. The exposed threaded portions of the broken tail rotor pitch control rod did not have either of the required corrosion preventative compounds applied, as per the Maintenance Manual.

Causes and Contributing Factors

The tail rotor pitch control rod assembly failed because of high cycle fatigue under service loads probably augmented by the deteriorated condition of the rod end bearing. Fatigue was found to be coincident with the stress concentration provided by the thread roots in the presence of corrosion pitting. Contributing to the incident was the absence of specific instructions to check for cracks in the tail rotor pitch control rod ends after the ASB had been complied with and the restricted requirement to inspect only the exposed threads of the rod ends. Also contributing to the incident was the absence of corrosion preventative coating materials and the failure to replace the rod end bearing.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 14 October 1999.