AVIATION INVESTIGATION REPORT
A00Q0046

IN-FLIGHT BREAK-UP

BELL 206B-III (HELICOPTER) C-GFSE
BELOEIL, QUEBEC
27 APRIL 2000

Aviation Investigation Report

In-flight Break-up

Bell 206B-III (helicopter) C-GFSE
Beloeil, Quebec
27 April 2000

Report Number A00Q0046

Summary

Around 1735 eastern standard time, the Bell 206B-III helicopter, serial number 2889, took off from Beloeil Airport, Quebec, in a northeasterly direction. The aircraft, with the pilot and one aircraft maintenance engineer on board, was making a visual flight rules flight to check the transponder. About five minutes later, after the pilot advised the area control centre controller that he was returning to the airport, the main rotor separated from the mast and the blades penetrated the cockpit. The helicopter crashed on its back in a plowed field 1.2 nautical miles northeast of the point of departure. A fire broke out after the impact and destroyed the aircraft. The two occupants sustained fatal injuries.

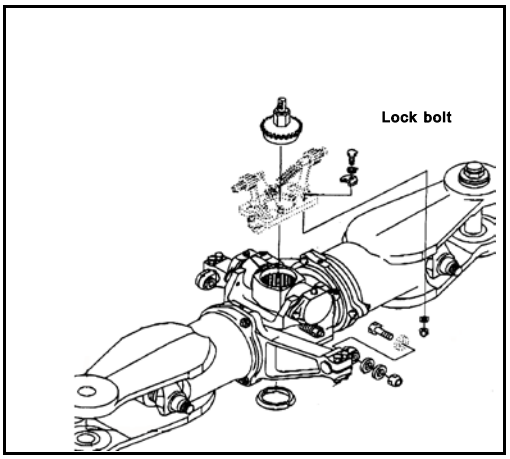
Ce rapport est également disponible en français.

Other Factual Information

The helicopter was imported from the United States in December 1999. The new owner signed a purchase service contract with S.C.G. Hélicoptère inc., which was to repair several deficiencies, make modifications, and do some cosmetic work. S.C.G. Hélicoptère inc. (formed in 1999 from the merger of two helicopter maintenance companies: Les entreprises aéronautiques Multi Air Services Inc. and Héliplan inc.) did not hold an approved maintenance organization certificate. Consequently, S.C.G. Hélicoptère inc. could not perform specialized maintenance or maintenance on commercial aircraft. Since it was a private aircraft, all work was done solely on the authority of the aircraft maintenance engineer (AME) who performed it. In this occurrence, the owner of Les entreprises aéronautiques Multi Air Services Inc., who was an AME, did the work required for the aircraft registration and airworthiness certificates.

In January 2000, the aircraft owner, who held a helicopter pilot licence, hired a commercial pilot for additional safety while flying and to oversee the day-to-day operation of the aircraft. The commercial pilot was expected to ensure all work listed in the purchase service contract was completed within a reasonable time. The deadline for completing the work was set at May 04. The registration certificate was issued on March 07. Transport Canada then issued a certificate of airworthiness on April 20 after a compliance inspection.

On April 25, the AME started to complete the work listed in the purchase service contract and to correct the deficiencies noted by the owner on pleasure flights on April 20 and 24. These deficiencies included the defective transponder, a leak in the ceiling, and corroded washers on the droop restrainers. A nut screwed onto the top of the mast secures the droop restrainers and the rotor head in place. A mechanical lock bolted to the droop restrainer plate is secured with a lock wire and prevents the mast nut from unscrewing in flight. After the mast nut is installed, an independent inspection is required. The work must also be entered in the aircraft logbook and signed off by either two AMEs or one AME and a qualified pilot.



At the request of the AME, an apprentice AME removed the droop restrainers and the mast nut from the aircraft, then stripped and primed them. The next day, April 26, the AME's partner, the owner of Héliplan inc., noticed that the apprentice AME had not used an epoxy primer, and he asked him to strip the parts again so he could paint them on the evening of April 27. At that time, no flights were scheduled for April 27. After the droop restrainers were stripped, they were placed on a tool box beside the aircraft; the mast nut and its securing mechanism were placed on another work table. The investigation could not determine whether the pilot was advised that the droop restrainers had been removed.

On April 27, the day of the occurrence, no other work was scheduled to be done on the helicopter. The AME was doing administrative work, and the apprentice AME was working on an aircraft beside C-GFSE. However, the pilot, who arrived at the hangar around 0930 eastern daylight time (EDT),[1] asked the AME to work on the

[1] All times are EDT (Coordinated Universal Time [UTC] minus four hours).

helicopter in preparation for some flights scheduled by the owner for April 28, in the Montréal control zone, and April 29. Consequently, the AME had to interrupt the job he was doing and devote the remainder of the day to servicing C-GFSE.

After replacing the transponder, the pilot and the AME pushed the helicopter out of the hangar around 1500 to find the water leak. Around 1730, the pilot started the aircraft and hovered it. The aircraft landed a few minutes later so the owner of Héliplan inc. could approach the helicopter and talk to the AME. The helicopter then took off toward the northeast around 1735 to check the transponder. At 1737, the pilot called the Montréal control centre to transmit his intentions. The flight determined that neither the transponder nor the altimeter was functioning. At 1740, the pilot advised that he was returning to Beloeil Airport; it was the last message received from C-GFSE. Radar recordings indicate that the aircraft was orbiting left when it vanished from the screen. Since the transponder was not working, the aircraft altitude was not displayed on the screen.

The wreckage trail was on a track of 350 degrees magnetic. The first debris, small fragments of plexiglass from the bubble and the cockpit interior finishing, was found 1200 feet south of the main wreckage. Several other parts were strewn about in the field, between the wreckage and the south end of the debris area. The two blades were found attached to the main-rotor hub about 400 feet southeast of the aircraft.

Examination of the hub revealed that the mast nut, the droop restrainers, and the spacer that replaces the droop restrainers when they are not installed were all missing. The internal threads in the holes where the droop restrainers attach to the hub were intact, and the examination revealed no attachment bolt debris. Examination of the main-rotor mast and the head trunnion indicated that the damage was caused by a vertical movement of the hub. The two pitch control rods failed in overload. Shortly after the occurrence, the droop restrainers and the mast nut for C-GFSE were found in the S.C.G. Hélicoptère inc. hangar at the same location where they had been left the day before by the apprentice AME.

No entries concerning the removal of the mast nut and the droop restrainers were made in the aircraft technical log, open job lists, inspection sheets, or worksheets. Under the *Canadian Aviation Regulations*, when work is partly completed, a general description of all remaining tasks must be logged, including the exact location of all systems or parts moved. This requirement is met when the open job lists, inspection sheets, or worksheets used on a job indicate clearly all the work that remains to be done. When work is completed, the person who did the work must enter the relevant information in the logbook as soon as possible after completing the work, but before the next flight at the latest. As a rule, the pilot checks only the logbook before a flight to ascertain the condition of the aircraft. The logbook of C-GFSE was found in the wreckage area. The investigation was unable to determine whether the pilot knew the mast nut had been removed. It was determined that the apprentice AME and the owner of Héliplan inc. forgot, before the aircraft took off, that the mast nut had been removed.

Some companies place a warning flag in the cockpit and/or on the fuselage to indicate that the aircraft is not airworthy and that maintenance work is in progress. This practice is not required by the *Canadian Aviation Regulations*. In this occurrence, neither the AME nor the apprentice AME followed this practice: there was no visual indicator that the mast nut was not in place.

The pilot was certified and qualified for the flight in accordance with existing regulations. He received his commercial pilot (helicopter) licence on 22 July 1986 and passed his pilot proficiency check on 14 June 1999. His licence validation certificate was valid, and he held a Class 1 flight instructor rating (helicopter). The pilot

was chief instructor for Québec Hélicoptère from April 1998 to January 2000, and he took the Transport Canada pilot decision-making course on 24 April 1999. Pilot decision-making training initiates pilots to the factors that affect human performance, the decision-making process, and how to counteract human error. A few days before the occurrence, the pilot had a cast removed from his right leg, which he had broken in March 2000. His peers considered him a conscientious pilot who did pre-flight checks.

The AME was licensed and qualified to service C-GFSE. He received his AME licence (helicopter) on 04 April 1985 and formed Les entreprises aéronautiques Multi Air Services Inc. in 1995. He was the only AME in the company, and he supervised the apprentice AME, who had four years' experience. Although the investigation did not precisely determine the AME's workload, it was established that he had been especially busy in the months preceding the occurrence. In addition to working weekdays, he worked on weekends and had practically no days off during this period. The AME worked an average of 12 hours a day.

While the *Canadian Aviation Regulations* do not specifically require a pre-flight check, the information in Chapters 1 to 4 of the aircraft flight manual, which includes the pre-flight checklist, is approved by Transport Canada and is required for the efficient and safe operation of the helicopter. Chapter 2 provides a detailed description of the pre-flight check and states that the pilot is responsible for determining whether the helicopter can complete the flight safely. The pilot should climb onto the cockpit roof to check the main-rotor head and hub. From the roof, it would be obvious if the mast nut were missing: the mast threads and opening would be visible. In fact, the droop restrainers and the mast nut can also be seen from the roof.

Analysis

Examination of the rotor head and its components indicates that the main rotor separated from the aircraft because the mast nut was not in place. The possibility that another mast nut was installed before the take-off and came loose in flight was rejected because all the mast nuts in inventory were found in the S.C.G. Hélicoptère inc. hangar. Consequently, the aircraft took off with no mast nut.

A description of the work to be done should have been recorded on one of the documents, as required by regulation to advise maintenance personnel. Maintenance personnel could have referred to the documents and could have prevented the aircraft from taking off. However, the three persons who could have performed the work (the apprentice AME, the AME, and the Héliplan inc. owner) were aware that the mast nut had been removed and was to be painted on the evening of the occurrence. It is unlikely the AME thought that the mast nut had been installed by the apprentice AME or by his partner because the AME had received no notification or indication that the work had been completed. Consequently, it is reasonable to believe that the three persons who took part in the removal of the mast nut, and who were present when the aircraft took off, did not remember that the mast nut was in the hangar. It is unlikely that the helicopter would have taken off without the mast nut if a document had indicated the work that remained to be done and if the AME had consulted that document before the flight. There was no indication that the pilot or the AME consulted the aircraft documentation before the flight. It would have been unusual for the pilot to consult the maintenance documentation.

The occurrence flight expedited the work to be done on the helicopter because it was not anticipated by the maintenance personnel. It had been decided that the droop restrainers and the mast nut would be painted that

same day. It seems that, after a schedule change, the work methods of the maintenance personnel did not enable the AME to be aware of the airworthiness status of the aircraft at all time.

It is likely that the pilot was not aware that the mast nut had been removed. Given that no visible warning device was placed in the cockpit or on the aircraft, there was nothing to tell the pilot that the aircraft was out of service. A visual aid such as a warning flag or sign, while not required by regulation, would have alerted the flight crew to the danger. Also, the missing mast nut undoubtedly would have been noticed by the pilot if a pre-flight check had been done as specified in the aircraft flight manual. Consequently, it is reasonable to conclude that the pilot did not climb atop the aircraft and did not examine the rotor head. Even if the restrainers were visible from the ground, noticing that something is missing is probably more difficult than noticing that something is present. The AME responsible for the maintenance of C-GFSE was on board the aircraft when it took off and had worked with the pilot during the hours preceding the flight; this certainly gave the pilot a false sense of security.

Findings as to Causes and Contributing Factors

1. The main-rotor head separated in flight because the mast nut was not in place.

2. The helicopter took off without a mast nut.

3. The pilot did not check the rotor head before the flight.

4. Maintenance documentation did not indicate that the mast nut had been removed.

5. No visible device was placed in the cockpit or on the aircraft to indicate that the helicopter was out of service.

6. The three persons who participated in the removal of the mast nut were present when the aircraft took off. None of them remembered that the mast nut was not in place.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 18 December 2001.