Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A03W0194

POWER LOSS AND DYNAMIC ROLLOVER

TRANS NORTH TURBO AIR LTD.
BELL 206B (HELICOPTER) C-GCHC
MAYO, YUKON TERRITORY 80NM N
16 SEPTEMBER 2003

Canada

Aviation Investigation Report

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Summary

A Trans North Turbo Air Ltd. Bell 206B (registration C–GCHC, serial number 1247) was supporting a diamond drilling crew working on the side of a mountain about 80 nautical miles north of Mayo, Yukon Territory. The helicopter was observed descending to a creek-bed staging/refuelling area. As it reached approximately 20 feet above ground, the observers lost sight of the helicopter behind an embankment and then heard impact sounds. On reaching the landing site, the observers found the helicopter lying on its right side between two fuel drums. The helicopter had sustained substantial damage, and the pilot, the sole occupant, had been fatally injured. The time of the occurrence was approximately 1205 Pacific daylight time. There was no post-crash fire.

Ce rapport est également disponible en français.

Other Factual Information

The staging/refuelling area was on a river bed at the base of a mountain, about 1200 feet from the crew camp and about 400 feet below the drilling platforms. The pilot had refuelled the helicopter with an unknown quantity of fuel from a fuel drum before commencing the flight. All removable equipment, emergency supplies, etc., were removed from the helicopter to reduce the empty weight. The pilot had also removed the right side pilot door to improve his visibility during slinging operations.

The drilling equipment had been disassembled and made into sling loads of approximately 700 to 800 pounds each, with the exception of the engine, which weighed about 900 pounds. The maximum weight of sling loads allowed for the Bell 206B (BH06B) by the operator for this contract was 900 pounds, within the limit for the helicopter. The equipment was moved from the previous drilling site to a holding area on the side of the mountain, then to the new drilling site platform. There were 13 transfers completed to the holding area over approximately 45 minutes. The last component to be moved was the drilling engine, which was transferred directly from the old platform to the new platform. The pilot operated the helicopter so as to have the fuel weight reduced to the minimum level to safely transfer the heavier weight of the engine before refuelling. After the engine was transferred, a short, unplanned trip was made to transfer some hydraulic equipment from the holding area to the new platform. The helicopter then abruptly departed the new platform and descended towards the staging area; the helicopter crashed on this flight. The time of the occurrence was approximately 1205 Pacific daylight time.[1]

The helicopter was found on its right-hand side on a heading of 175° Magnetic. An open fuel drum was lying beside the left forward fuselage. An electric pump that was attached to the top of the drum had broken off and was under the nose of the helicopter. A second fuel drum, which had been struck by a main rotor blade, was found beside the right forward fuselage. Both drums were leaking fuel.

A short line, 25 feet long, was found attached to the belly hook of the helicopter and trailed out to the left of the wreckage. The fuselage of the helicopter was mostly intact, but the tail boom, tail rotor drive shaft, and control shaft had sheared forward of the horizontal stabilizer. Impact damage was greatest on the upper right section of the fuselage. There was no visible damage to the skid gear. The main rotor had separated from the mast and was at the base of the riverbank about 30 feet from the main wreckage. The collective control was at the top of its travel, the throttle was fully open (high power), and the engine automatic relight system was armed. Other controls and switches were in the normal flight mode.

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[1] All times are Pacific daylight time (Coordinated Universal Time [UTC] minus seven hours).

The fuel tank and system were intact and undamaged, with the fuel filler and range extender on the right side under the wreckage. Examination of the fuel system at the accident site revealed fuel throughout the lines and filters, but no fuel in the tank. Fuel leakage from the filler and fuel tank vent after the occurrence could not be determined because of the nature of the riverbed surface and the presence of fuel spilled from the drums.

During the initial recovery phase, when the wreckage was being lifted from the site by a Trans North Turbo Air AS350 Astar helicopter, the hook released due to a mechanical malfunction. The wreckage was dropped to the ground from an altitude of about 100 feet causing considerable additional damage to the forward cockpit/cabin and instrument panel. Further examinations were conducted at the Transportation Safety Board (TSB) Regional Wreckage Examination Facility with representatives from the operator, the engine and airframe manufacturers, and Transport Canada (TC) present. The engine fuel control unit, governor, fuel pump, and fuel system boost pumps were tested at overhaul facilities. Flight control system hydraulic servos were function tested and examined after disassembly. All components performed to the proper specifications. The fuel quantity gauging system could not be tested, but no pre-impact unserviceabilities had been reported.

The damage to the main and tail rotor drive systems, and the mast fracture surfaces examined by the TSB Engineering Branch, indicated low power was being produced at impact. Aluminum alloy composition metal splatters were found on the nozzle vanes of the power turbine. The splatters were well blended with the vane surface and consistent with the flow of fully molten metal at high temperatures, as opposed to a partially solid (pasty) type of deposit formed at lower temperatures. The aluminum was most likely pieces of the particle separator located forward of the air intake, but the origin of it was not determined.

The company’s operations manual required that the pilot-in-command ensure there was “sufficient fuel and oil on board the helicopter for the planned flight with a minimum reserve of 20 minutes at normal cruising speed.” This was consistent with TC’s regulations concerning fuel requirements for helicopters operating under visual flight rules. A cruise power setting of 80 percent would result in a consumption rate of 25.6 gallons per hour; the 20-minute reserve would have been 8.5 U.S. gallons (57.6 pounds) of fuel.

The fuel system of the BH06B is equipped with two electric fuel boost pumps mounted fore and aft in the bottom of the tank to ensure an uninterrupted flow of fuel from the tank to the engine. Fuel unporting is a phenomenon whereby fuel flows away from the fuel pick up in the fuel tank, and will result in a power loss or engine failure due to fuel starvation. Unporting is a function of the amount of fuel available (usually very small quantities), the attitude of the helicopter, and sloshing of the fuel in the tank.

The normal longitudinal centre of gravity (C of G) limits are from 106.0 to 114.2 inches aft of the datum, but with the forward door removed, the limits were restricted to 106.0 to 110.0 inches aft of the datum. The longitudinal C of G of GCHC at the calculated weight of 2170 pounds was 111.04 inches aft of the datum, or 1.04 inches aft of the restricted limit. Lateral C of G was +1.49 inches (right of centre), within the lateral C of G limits of -3.0 (left) to + 4.0 (right) of centre.

Mayo was the nearest weather reporting station in the area. At 1800Z, the reported weather at Mayo was as follows: wind calm, visibility 20 statute miles (sm), ceiling 9000 feet overcast, temperature -3°C, and dew point -8°C. The geographic area forecast valid for 1800Z indicated that the Yukon Territory was largely under the influence of a high-pressure system with broken cloud layers from 10 000 to 18 000 feet, with visibilities forecast to be better than 6 sm. At the time of the occurrence, the ceilings and visibilities did not hinder the slinging operation, and the winds were light. Weather was not considered to be a factor in this occurrence.

The pilot's flying career began in the military in 1977, and he became a civilian pilot in 1997. He was qualified for the flight in accordance with existing regulations and had a valid airline transport pilot licence (helicopter), with a Group 4 instrument rating. He was endorsed for BH06, HV07 and MBH5 helicopters, with a total flight time of about 5250 hours. The pilot's helicopter flight time was about 3250 hours, of which 2700 hours were in the BH06 series.

An autopsy attributed the cause of death to blunt-force head injuries, and death was likely to have been instantaneous. First on the scene were members of the drilling crew who removed the pilot from the wreckage and noted that he was wearing his helmet. The helicopter was equipped with a four-point harness, which had to be released to extricate the pilot. The rescuers could not recall if the shoulder harness was attached, but based on the pilot's injuries, it is probable that the shoulder harness was used. Examination of the open-earpiece style helmet found damage on the right side around the headphone opening that was consistent with the injuries sustained by the pilot.

The post-mortem examination report states that there were multiple microscopic granulomas on the pilot's lungs, heart and liver. The report further states that the presence of a granuloma in the heart raises a possibility that the pilot suffered an arrhythmia while flying the helicopter. In 1983, the pilot was diagnosed with sarcoidosis, which was consistent with the presence of these granulomas. Sarcoidosis is a common chronic disease and does not normally result in lasting harm to tissues. When manifested in the heart, sarcoidosis in an active state can result in arrhythmia, including a sudden loss of consciousness. In its inactive stage, the granulomas are stable or shrinking, or have become scars. It is not known when the pilot contracted sarcoidosis, but the disease was inactive when diagnosed in 1983. The pilot's condition had been examined and tracked by both military and civil aviation medical examiners for about 20 years since the initial diagnosis. No changes had been noted in the status of the condition, and the pilot's Category 1 medical certificate remained valid throughout the entire period.

Dynamic rollover is a phenomenon whereby the helicopter's lateral roll angle exceeds its critical rollover angle. This angle is achieved when the helicopter's C of G is displaced laterally over a pivot point, usually the landing gear, such as when the helicopter is travelling sideways during lift off or landing. Once the lateral position of the C of G moves beyond the pivot point, the helicopter has rolled beyond the pilot's cyclic control authority and the roll cannot be arrested. The greater the distance between the C of G and the pivot point, the greater the moment arm and rotational speed. A pilot may not recognize entering into the regime of a dynamic rollover because the initial roll rates are well within the normal range experienced in flight, while the actual rollover can be almost instantaneous. The recognized recovery procedure from the early stages of a dynamic rollover is to apply down collective in order to control the rolling motion. A pilot's training and reflex action may cause him to raise the collective to fly out of a situation during descent or landing, but raising the collective during a dynamic rollover situation will also increase the roll rate.

The following TSB Engineering Laboratory report was completed:

LP 108/03 – Power Turbine Nozzle Analysis

This report is available from the Transportation Safety Board of Canada upon request.

Analysis

Damage to the rotor drive system and the mast indicated low or no power being transmitted from the engine at impact, although the throttle was fully open. Engine and component examination revealed that the engine, accessories, pumps and controls were capable of functioning normally, with no mechanical deficiencies found that may have caused an engine deceleration or power loss. Fuel was found throughout the fuel lines and filters, indicating that fuel was being supplied to the engine. The condition and location of the metal splatters on the power turbine nozzle vanes indicate that the temperature and airflow through the combustion section during impact were sufficient to fully melt the aluminum pieces ingested during the breakup sequence, indicating the engine was operating.

The amount of fuel on board prior to the occurrence could not be determined. However, the quantity had been planned to be near the minimums required by regulations for the transport of the drilling engine. Fuel consumption would have been considerably higher at the higher power requirements during slinging operations, and the reserve quantity may have been less than originally planned. The additional shuttle of a load of hydraulic components would have further reduced the reserve fuel quantity by at least 2.0 gallons. A low fuel state may have been the reason the pilot abruptly departed the new platform for the refuelling site.

With an aft longitudinal C of G and a right lateral C of G, the helicopter was probably in a tail-low, right-side-low attitude. When combined with the lateral manoeuvring toward the right during the approach, this attitude would have increased the tendency for the fuel to migrate to the right rear corner of the fuel tank. The fuel pump intakes probably unported, causing an interruption in the fuel flow and a loss of power. With the engine relight system armed, any resumption of fuel flow could result in an engine relight, or series of relights, but without the time required for the engine to accelerate and transfer a useable amount of power to the rotor drive system prior to impact.

A loss of power in the final stage of the flight, in itself, should not have been a serious event, given the pilot's level of training and experience. The approach to the fuel drums in a right lateral descent while laying out the short line to the left would have been a standard procedure. It is probable that the pilot's attention would have been partially directed to his left toward the line. A momentary power interruption at a crucial moment may have distracted the pilot, and caused the helicopter to overshoot the intended touchdown area and continue laterally onto the fuel drum. Right skid contact with the top of the drum and the projecting fuel pump resulted in a dynamic rollover. The position of the collective at the top of travel may have been the result of the pilot inadvertently lifting as the aircraft rolled over, or he may have been attempting to cushion the landing after the power failure without realizing the skid had contacted the pump. Raising the collective could have increased the rollover rate.

The pilot was wearing his helmet; however, the severity of the impact caused the helmet to fail around the side where the shell had been cut away for accommodation of the headphone earpiece. A full-shell helmet, which has the earpiece inside the shell, would have been structurally stronger and afforded better protection.

Finding as to Causes and Contributing Factors

1. The helicopter crashed due to a dynamic rollover that resulted from the landing gear skid contacting the fuel pump that was projecting from the top of a fuel drum. It could not be determined why the helicopter struck the fuel pump/drum.

Findings as to Risk

1. The pilot's open-earpiece type helmet did not provide the level of side impact protection that a full-shell type helmet would have, and this may have contributed to the severity of the injuries.

2 The operation of a helicopter at or below minimum fuel levels is conducive to unporting, which may result in a sudden loss of power at a crucial moment.

Safety Action

The operator has advised its pilots not to purchase or utilize the older military style of open-earpiece helmets, since the open-earpiece type helmet does not provide the level of side-impact protection that a full-shell type helmet would provide.

As a result of this investigation indicating unporting as a risk, the operator has issued a memo to all flight crews mandating a minimum indicated fuel load of 15 U.S. gallons during all Bell 206 operations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 February 2005.