

AVIATION INVESTIGATION REPORT

A97P0207

COLLISION WITH TERRAIN

NORTHERN MOUNTAIN HELICOPTERS INC.

BELL 206B (HELICOPTER) C-GVQK

BEAR VALLEY, BRITISH COLUMBIA

30 JULY 1997

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 pilot of the Bell 206B helicopter (serial number 478) was engaged in transporting survey crews in the Bear Valley area, about 45 nautical miles (nm) north of Mackenzie, British Columbia. On the morning of the accident, he had begun flying at about 0645 Pacific daylight time (PDT). A survey crew contacted the pilot by radio at about 1200 and requested a pick-up for about 1400; they also informed the pilot of a 100- to 150-foot ceiling and a visibility of about 300 metres (1000 feet). At about 1445, the pilot was attempting to locate the survey crew at the 5100-foot elevation, but low cloud, fog, and precipitation prevented him from making visual contact with the landing area. The pilot was in two-way radio contact with the ground crews and remarked that the lower pick-up pad was fogged in and that he could not see the trees or ground below him. The pilot continued manoeuvring in the area, searching for the landing pad. Witnesses on the ground then saw the helicopter appear from the base of the low cloud, in a right-hand, descending turn, roughly in a 40-degree nose-down and 40-degree right-bank attitude before it struck trees and collided with the terrain at 5200 feet above sea level (asl), inside a cirque. The pilot was fatally injured, and the helicopter was destroyed by impact forces and a post-crash fire.

Ce rapport est également disponible en français.

Other Factual Information

The helicopter was manufactured in 1969, and maintenance records reveal that the helicopter was certificated, equipped, and maintained in accordance with existing regulations and approved procedures. As of 26 July 1997, it had 11 640 hours of flight time, and the Allison 250-C20B engine had 10 003 hours. The helicopter's weight and centre of gravity at the time of the accident are not conclusively known, but based on the day's previous activities, it is estimated that the weight and balance were within the prescribed limits and that there was sufficient fuel on board for the flight.

The helicopter struck the rocky surface at a high impact angle and was damaged by an intense post-crash fire, except for the aft section of the tail boom, the tail rotor assembly, two doors, and fragments of the skid gear. No flight or engine instruments were recovered, except for the face of the engine torque gauge. The TSB Engineering Branch examination of this dial did not reveal any impact-related reading. All flight controls were destroyed by impact and fire. The main rotor gearbox and the engine gearbox were also destroyed by fire. An examination of the gears and bearings that remained did not reveal any anomaly or indication of pre-impact distress or malfunction. The aircraft systems were examined to the degree possible, and no sign of a malfunction was found.

Four days before the accident, the pilot had experienced smoke in the cockpit resulting from an electrical short circuit in the directional gyro (DG). Company maintenance personnel in Mackenzie removed the DG and inspected the associated wiring loom and cannon plug; the helicopter was then test-flown and returned to the Bear Valley camp without the DG installed. The removal of the DG did not affect the airworthiness of the helicopter. The DG was not required for the pilot to navigate in visual meteorological conditions (VMC), since a magnetic compass was installed in the helicopter as standard equipment. The absence of the DG could have affected the pilot's ability to fly in instrument meteorological conditions (IMC). The accident helicopter was not authorized to fly under instrument flight rules (IFR) conditions.

Witnesses recalled that when the helicopter departed on this trip, waves of low cloud and fog were moving through the area, and the visibility had diminished to about one mile in drizzle; the sky condition at the drop site was described as a solid overcast around 600 feet above ground level (agl). These weather conditions reportedly persisted throughout the day. Witnesses also reported that there was very little wind at the time of the accident, that light rain was falling, and that the fog and low cloud coming up the slope caused an overcast ceiling of about 300 feet agl. About two hours after the accident, the same weather conditions prevented another helicopter from landing at the accident site. The weather reporting station nearest the accident area is 45 nm away in Mackenzie. At 1300, the automated weather observation system (AWOS) at Mackenzie had recorded a measured ceiling of 700 feet overcast and a visibility of more than 9 miles. At 1400 the sky condition was 500 feet scattered, 1600 feet broken, and 2800 feet overcast, and the visibility was more than 9 miles, in very light drizzle. In the hour between these reports, four special observations recorded a broken ceiling as low as 500 feet. Based on witnesses accounts, however, the weather conditions at the accident site

¹ All times are PDT (Coordinated Universal Time minus seven hours) unless otherwise noted.

were significantly different from the Mackenzie AWOS. This was likely because of the distance and the mountainous terrain, which is known to create unpredictable local weather conditions.

The 45-year-old pilot had recently begun his career in aviation, and had accumulated about 400 hours of total flying time. He held a Canadian commercial helicopter pilot licence (CPL-H), endorsed for the Bell 47 and 206 helicopters, for daylight flying only, and a valid medical certificate. The pilot did not hold an instrument rating, nor was it required, since this operation was to be conducted under visual flight rules (VFR). The pilot had attended a course on pilot decision making in April 1997. His only exposure to instrument flying was during basic training toward his CPL-H.

In early May 1997, the pilot had successfully completed the operator's Upgrade Training Program, which included mountain-flying and reduced-visibility training, and his pilot proficiency check. On May 12 he began as a base pilot in Mackenzie, and on July 2 the pilot assumed his duties at the Bear Valley camp. The Bear Valley contract was the pilot's first commercial assignment and his first exposure to remote-base and self-dispatch operations. He was expected to make routine operational decisions involving customer requirements, weather, helicopter serviceability, and the suitability of the terrain, although he could easily consult with the operations bases in Prince George or MacKenzie. On July 7 he experienced a main rotor blade strike during a confined-area approach in the Bear Valley area. The next day, the company chief pilot carried out an evaluation flight and debriefing with him before he returned to the Bear Valley operation and continued his assignment.

The pilot had flown about 120 hours in the 30 days before the accident and at least 16 hours in the last 3 days; he was scheduled to begin his time off the following day. An examination of the pilot's flight time/days off records revealed at least 12 instances in the previous 70 days where his flight- and duty-times exceeded the limits specified in the *Canadian Aviation Regulations* (CARs Sections 700.16, 720.16, and 720.17). During the 30 days before the accident, the pilot did not have the required 8 hours of rest on five occasions and had exceeded the 14-hour duty time limit on eight occasions, the most recent being on the day before the accident.

It is apparent from his records that the pilot had been filling in the forms incorrectly. If filled in correctly, these records would have allowed the pilot and the operator to accurately maintain and monitor his flight time and duty time to prevent him from exceeding the daily and cumulative limits specified in the CARs.

On 28 April 1992, Transport Canada (TC) conducted a regional audit of Northern Mountain Helicopters Incorporated (NMH) and identified several areas of non-conformance, mainly regarding pilot training records, flight- and duty-time records, and aircraft journey log entries. As a result of this audit, the company pledged to undertake a plan to rectify the areas of concern. TC carried out another in-depth audit of the company between May 11 and May 22, 1998, which focussed on the 18-month period from October 1996 to May 1998. The purpose of the audit was to assess the operator's level of conformance with the regulations and standards governing the operations of Canadian air operators. The results of this 1998 audit noted that significant changes in the company structure and operations following the 1992 audit were insufficient to address all of the noted deficiencies.

In the six-year period between the audits, the TC Centre (TCC) in Prince George, British Columbia (B.C.), had carried out maintenance inspections and audits of several NMH bases. These inspections/audits and their results were recorded in the Prince George TCC, but were not forwarded to the TC Pacific Region office in Vancouver, and the 1998 audit did not reflect the Prince George inspections. The inspections carried out by the TCC identified frequent maintenance-related deficiencies; TCC inspectors later assessed most of the company's responses to these findings as satisfactory.

Nevertheless, in January 1996 a TCC audit of the NMH aircraft and maintenance facilities identified 17 deficiencies, several of which were recurring since the audit carried out in January 1994. As a result, TC Airworthiness sent a letter to NMH stating that TC was alarmed at the results, and warned that the Approved Maintenance Organization Certificate, number 144-90, would be suspended if the company did not meet the requirements of the letter. The certificate was not suspended at that time.

In December 1997, about five months after the accident, TC Pacific Region issued NMH two Notices of Suspension, one each for the Canadian Air Operator Certificate, number 1518, and the Approved Maintenance Organization Certificate, number 144-90, because TC determined that the company had failed to comply with the conditions required for the issuance of these certificates. Following response by NMH to the conditions of the suspensions, TC later withdrew the Notices of Suspension.

At the time of the 1998 audit, NMH offered domestic, non-scheduled international, and aerial work air services from the main base at Prince George, B.C., and from eleven sub-bases in B.C., one sub-base in Ontario, and two international operational bases in Sudan and Congo. NMH operated a mixed fleet of about 70 aircraft and held Air Operator Certificate number 1518. The operator employed about 130 pilots and operated under Subparts 702, 703, and 704 of the CARs in diverse flight operations such as general charter, heli-logging, forest fire management, aerial construction, and seismic support.

As a result of the 1998 audit, a total of 54 airworthiness findings and 17 operational findings were made, several of which TC assessed would have had an impact on flight safety. TC technical inspectors noted several deficiencies in the areas of technical records, maintenance schedules, defect deferral, maintenance dispatch, and quality assurance. According to TC, the airworthiness findings suggested that the company had less-than-acceptable control over various components on the maintenance system and that, as evidenced by the number and seriousness of the findings, the company had made little effort to comply with all aspects of the (then) new CARs.

TC operational inspectors identified several areas of concern resulting from the audit. The most important of these were the lack of effective flight and duty time monitoring, and poorly kept pilot training records. These deficiencies had the potential to adversely affect flight safety. The TC auditors found that the flight crew training program was lacking in several areas, notably in training for flight in reduced visibility. Further, pilot training records were found to have been inaccurate and incomplete. The TC auditors found that the system in place for tracking pilot flight and duty times was extraordinarily inaccurate and ineffective. As well, the auditors made five findings regarding company pilots exceeding the flight- and duty-time limitations contained in the CARs. Three of these findings concerned the accident pilot: he had less than the required minimum rest

periods on five occasions; he had duty time in excess of the maximum on five occasions; and he had been given only two days of rest in the 31-day period before the accident (OP-09-01 to OP-09-03).

In partial summary, the audit revealed the following about the operator:

1. the maintenance control system did not comply with Commercial Air Service Standards;
2. company aircraft were not maintained in accordance with an effective maintenance control system that met the requirements of CAR Part VII - Commercial Air Services, Subpart 6 - Aircraft Maintenance Requirements for Air Operators;
3. pilots had not completed the required ground- and flight-training programs;
4. the system to monitor flight time, duty time, and rest periods was not followed; and,
5. each pilot was not provided with the required time free from duty.

On 4 June 1998, as a result of this audit, TC issued the operator a Notice of Suspension under Section 7.1(1)(b) of the *Aeronautics Act*, effective 8 June 1998. To avoid further action against the operator's Air Operator Certificate, TC required the operator to comply with the conditions specified in the Notice of Suspension within 30 days. On 8 June 1998, a Special Inspection Team from TC examined the operator's compliance with the conditions. In summary, TC found that the operator had "co-operated on all levels with a clear understanding of deficiencies identified." As well, TC noted that "steps were already being taken to correct deficiencies and prevent future occurrence." Accordingly, the Notice of Suspension was withdrawn.

Nevertheless, the operator's responses to the operational finding concerning the accident pilot (OP-09-01 to 03) were all assessed as unacceptable by TC in July 1998. The TC inspector noted that the operator's responses put into question the operator's grasp of the flight- and duty-time limitations. The inspector also noted that more was needed to educate the flight crews about flight and duty times and to enforce the limitations of the CARs. TC has continued to monitor the operator since that time and has assessed as satisfactory the operator's response to each deficiency noted since.

Fatigue is a debilitating phenomenon which slows reaction time, reduces concentration, and can lead to errors of attention. The performance and judgement of an individual suffering from fatigue becomes degraded, and one common effect is an increase in that individual's willingness to take risks and a tendency to finish tasks more quickly. The two most common causes are insufficient rest and a lack of sleep. Research shows that, although individual needs vary, the majority of the population requires between 7.5 and 8.5 hours of sleep in a 24-hour period. If people obtain less than their requirement, they develop a *sleep debt*, which is cumulative. This occurs when insufficient quantity of sleep continues over several consecutive days. For example, missing one hour of sleep per day for four days has about the same effect as missing four hours of sleep in one night. Furthermore, the impact of sleep debt is compounded when it is combined with a long day.

On the ground, spatial orientation is sensed by the combination of vision, muscle sense, and specialized organs in the inner ear, which sense linear and angular accelerations. Vision is the strongest of the orienting senses, and in visual flight, the pilot relies on regular visual references with the ground and horizon to control the aircraft attitude and altitude. If a pilot is in cloud, the visual reference to the ground and horizon is lost. As a

result, the available cues (solely from the external forces on the body) often produce spatial disorientation in flight, because the pilot has a false impression of aircraft attitude and motion. Under these conditions, the pilot is completely dependent on the flight instruments and learned flying skills for control of the aircraft. Inexperienced pilots with little instrument time are particularly susceptible to spatial disorientation when they are confronted with no external visual attitude references. Without suitable flight instruments or skills, a disoriented pilot would quickly lose control of the aircraft. Research found in the FAA Advisory Circular 60-4A, shows that a pilot can take as long as 35 seconds to re-establish full control of an aircraft by using instruments alone. In that period, the pilot spends at least five seconds recognizing that a hazard exists, determining the necessary corrective action, and responding to it. Instrument flight training in itself does not prevent disorientation, rather it provides the pilot with the ability to overcome it.

Analysis

The pilot may have decided to attempt the crew pick-up in adverse weather conditions because of his reluctance to leave the survey crews stranded and his desire to do well in his first unsupervised assignment. His assessment of the potential risks involved may have been influenced by his limited experience.

The survey crews saw the helicopter emerge from the low clouds in an extreme flight attitude, which was not consistent with controlled flight in this type of helicopter. The crews' description of the brief flight path before impact, as well as wreckage and impact characteristics, indicate that the pilot had insufficient time or altitude to prevent the collision with the terrain. Such a loss of control most likely was the result of spatial disorientation.

While the possibility exists that a mechanical malfunction did occur, no definitive conclusions about the mechanical condition of the helicopter can be drawn from the available wreckage. The remainder of the analysis will focus on the possible human performance aspects of this accident.

The absence of the DG, while not affecting the pilot's ability to navigate in VMC, could have limited his ability to maintain control in IMC. Although the weather conditions reported by ground observers were not consistent with VMC, the actual in-flight conditions experienced by the pilot are not conclusively known. It is probable the pilot encountered the same conditions as those that were observed and that, as a result, he rapidly became disoriented.

The pilot had, on occasion, exceeded the limitations concerning flight time, duty time, and rest periods. As well, several days before the accident, he had entered into a period when, although individuals can vary, the average person would have experienced serious cumulative sleep debt. Although the pilot recorded a normal sleep period immediately before the day of the accident, it is possible that the effect of the recent sleep debt may have adversely affected his performance or decision-making ability. It could not be determined if fatigue-related factors contributed to the circumstances of this accident; nonetheless, the workload and schedule of the pilot included periods when the risk of fatigue-related performance decrements would have been elevated.

TC audit findings show that the operator had not exercised effective operational control of the company's maintenance and operational activities. In particular, the method for tracking pilot flight and duty time was ineffective and inaccurate. This allowed the accident pilot to exceed the maxima, and it prevented the operator from monitoring and regulating the pilot appropriately. Such lack of operational control and administrative support may have increased the burden of workload on the accident pilot, perhaps exacerbating his overall stress and fatigue levels and diminishing his judgement.

The TC audit of the company in 1992 revealed several areas of non-conformance, and the company pledged to rectify the areas of concern. However, it was not until the regulatory audit from 11 to 22 May 1998, following this occurrence, that TC carried out another audit of the company.

TC issued repeated warnings of suspension of the company's maintenance and operational activities during the period between the audits, ultimately precipitating the most recent Notice of Suspension of the Air Operator Certificate in June 1998. Following the 1992 Transport Canada audit, deficiencies related to the company's air operator certificate and the approved maintenance organization certificate, were either not eliminated or were allowed to re-emerge.

Findings as to Causes and Contributing Factors

1. The weather in the vicinity of the accident made it unlikely that the flight could be completed in visual meteorological conditions.
2. The helicopter emerged from the low cloud base in a steep, nose-down turn, and there was insufficient altitude and time to prevent the aircraft from striking the ground.
3. The pilot likely experienced spatial disorientation and lost control of the helicopter.

Findings as to Risk

1. The pilot's work/rest schedule increased the probability of him making fatigue-related errors in both aircraft handling and judgement.
2. According to the company records, the pilot had, on several occasions, exceeded the legislated flight- and duty-time limitations of the CARs.
3. Transport Canada audits carried out after the accident revealed deficiencies in the company's control of maintenance and operational activities.

4. Following the 1992 Transport Canada audit, deficiencies related to the company's air operator certificate and the approved maintenance organization certificate, were either not eliminated or were allowed to re-emerge.
5. The pilot had no formal instrument flying training or experience beyond that provided in his commercial helicopter flight training syllabus.

Other Findings

1. The pilot was licensed and qualified for VFR flight.
2. The pilot did not hold an instrument rating nor was one required for the planned operation.
3. Records indicate that the helicopter was certified, equipped and maintained for the operation.
4. No indication was found of any pre-impact failure of the helicopter, its engine or systems.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 August 2000.