Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT A12P0079

LOSS OF VISUAL REFERENCE AND COLLISION WITH TERRAIN

BAILEY HELICOPTERS LIMITED
EUROCOPTER AS350-B2 (HELICOPTER), C-FBHN
TERRACE, BRITISH COLUMBIA 14 NM W
01 JUNE 2012

Canada

Aviation Investigation Report

Loss of Visual Reference and Collision with Terrain

Bailey Helicopters Limited
Eurocopter AS350-B2 (Helicopter), C-FBHN
Terrace, British Columbia 14 nm W
01 June 2012

Report Number A12P0079

Summary

The Bailey Helicopters Limited Eurocopter AS350-B2 helicopter (registration C-FBHN, serial number 3763) departed Terrace Airport at 0754 Pacific Daylight Time for a local mountain training flight, with 2 pilots and 1 aircraft maintenance engineer on board. At 0841, the helicopter struck the snow-covered side of a mountain ravine in daylight conditions at about 4000 feet above sea level. The 406-megahertz emergency locator transmitter activated on impact, resulting in the initiation of search activities. A local commercial helicopter operator located the accident site about 1 hour 50 minutes later. There was no fire. The aircraft was destroyed, and there were no survivors.

Ce rapport est également disponible en français.

Factual Information

History of the Flight

The sole base pilot for Bailey Helicopters Limited (BHL) at Terrace was preparing to take some leave. In preparation, a training flight was planned to provide a relief pilot with some familiarity with the local area, as well as hover-exit [1] and mountain-flying training. The relief pilot arrived in Terrace the evening before the training flight. The base pilot's leave was to commence the day after the training flight.

A company flight itinerary was filed with BHL dispatch office in Fort Saint John, British Columbia, and included the company aircraft maintenance engineer (AME) as a passenger. The flight departed the Terrace Airport at 0754. [2] The helicopter remained within 15 nautical miles (nm) of Terrace and proceeded north along the east side of the Kitsumkalum River valley. Recorded global positioning system (GPS) data from 3 different on-board units showed some manoeuvres at 2 locations before the helicopter proceeded westbound across the Kitsumkalum River (Figure 1). On the western side of the valley, the helicopter entered a ravine heading southwest and flew along the right-hand or south-facing side of the ravine. Near the top end of the ravine, at about 3800 feet above sea level (asl), the helicopter made a 180° left turn and proceeded part of the way back, in a descent, along the north-facing slope of the ravine. The helicopter then made a right-hand turn, crossed over a ridge, and descended into another parallel ravine. The helicopter turned to the southwest again up the ravine, and proceeded in a climb, while the ground speed was declining, following the terrain contour along the left side of the ravine.

The helicopter was climbing at about 1000 feet per minute (fpm) until it quickly levelled off at about 4500 feet asl and 45 knots ground speed. It commenced a right-hand turn near the top end of the ravine. As the helicopter turned, it maintained 4500 feet for about 9 seconds before it began descending at an accelerating rate, with increasing ground speed and tightening radius of turn. Recovered data recorded at 1-second intervals showed that the helicopter completed a turn of about 285° in 25 seconds and descended the last 220 feet to the accident site in 3 seconds (4400 fpm). It struck the 30°-inclined snow-covered slope in a slightly left-of-centre, frontal collision at about 4000 feet asl (54.563° N, 128.933° W) at 0841.

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[1] The purpose of hover-exit training is to allow passengers to exit a helicopter while it is hovering close to the ground.

[2] All times are Pacific Daylight Time (Coordinated Universal Time minus 7 hours) unless otherwise noted.

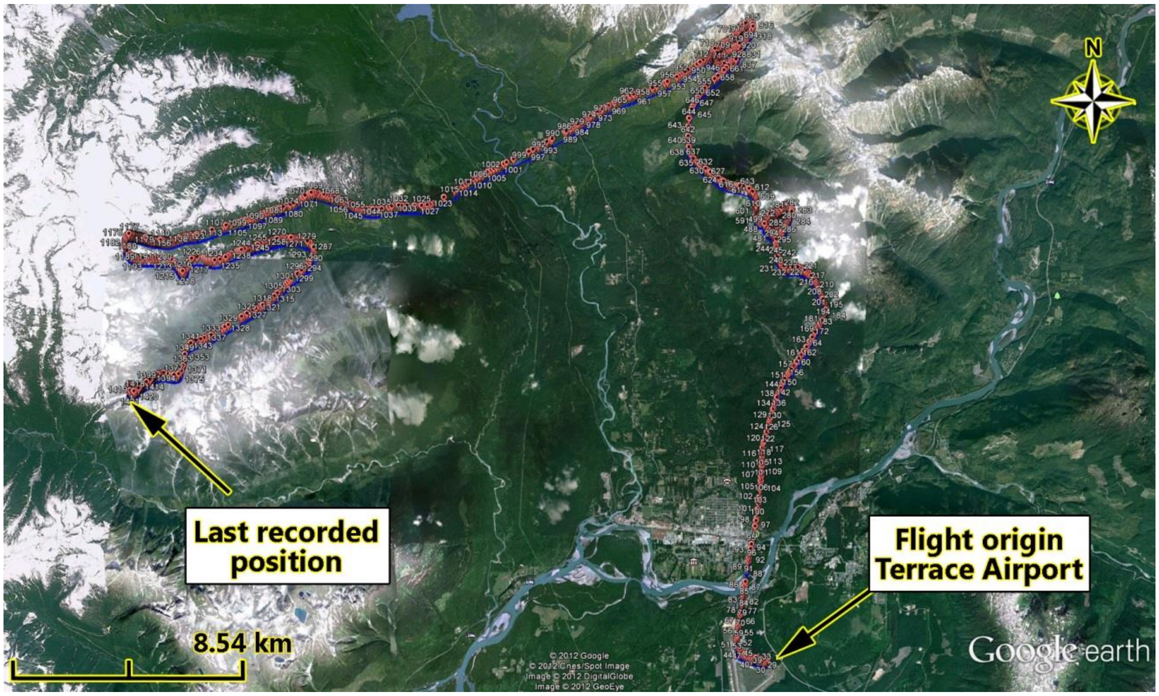

Figure 1. Plot of GPS data from the occurrence flight (image: Google Earth)

Weather

The aviation routine hourly weather report (METAR) at 0800 for Terrace was reporting winds from the northwest at 11 knots, visibility 8 statute miles (sm) in light rain, a few clouds at 900 feet above ground level (agl), a few clouds at 2500 feet agl, and overcast at 4000 feet agl. The temperature was reported to be 6°C and the dew point 4°C. The elevation of the Terrace Airport is 713 feet asl.

The latest Terminal Area Forecast (TAF) for the Terrace Airport, valid for a 5-nm radius of the airport, was issued at 0600. Forecast conditions included winds from the north at 10 knots gusting to 20 knots and visibility of 6 sm or better, with a few clouds at 3000 feet agl and broken clouds at 6000 feet agl. The forecast contained a temporary condition from 0600 until 1000 (for the period surrounding the accident flight) of 6 sm or better visibility in light rain, with ceilings becoming broken at 3000 feet agl.

The graphical area forecast (GFA) for the area surrounding Terrace Airport was valid at 0500 for 12 hours. The clouds and weather section of this forecast included broken cloud layers between 2000 and 4000 feet asl with patchy ceilings of 800 to 1500 feet agl, and visibility of 3 to 6 sm in light rain showers and mist. Also forecast were isolated towering cumulus clouds with visibilities of 2 sm in moderate rain showers and mist. The icing, turbulence, and freezing level section of this forecast indicated a freezing level of about 5000 feet asl, with the possibility of patchy mixed moderate icing at and above the freezing level.

In summary, the information indicated a cloudy and rainy day, with most of the mountain peaks obscured by cloud. The forecast predicted deteriorating ceilings and predicted that patches of clouds could be present in valleys.

At the time the helicopter was located, weather conditions in the area of the crash were reported to be an obscured ceiling in snow and rain, low visibility, and icing conditions. The winds were around 5 to 10 knots.

Aircraft

The Eurocopter AS350-B2 is a single-engine, 6-seat, single-pilot, turbine-powered helicopter. It has a 3-blade main rotor. The pilot flies from the right-hand seat. C-FBHN was equipped with an external cargo basket installed on the left-hand side of the helicopter, and dual controls were installed for the training flight. The flight control system is comprised of mechanical linkages that transmit pilot control inputs to hydraulic servo actuators.

The helicopter was certified and equipped for daytime visual flight rules (VFR) flight. Flight instrumentation included an airspeed indicator, an artificial horizon which incorporated a ball-in-tube slip and skid indicator, an altimeter, a VHF (very high frequency) omnidirectional range / instrument landing system receiver and display, a gyroscopic direction indicator, and a vertical speed indicator. The helicopter was not equipped with any type of autopilot or stability augmentation system.

The helicopter was equipped with a helicopter performance monitoring system, which recorded engine operating parameters at 1-minute intervals.

The helicopter was equipped with a warning/caution/advisory panel consisting of 17 operational annunciator lights, with 2 bulbs in each one. During normal operations, all of these annunciators should be off.

Maintenance records indicated that the helicopter was maintained in accordance with approved procedures.

Weight and Balance

The helicopter was carrying a pilot in each front pilot seat and 1 passenger in the rear outer left seat, approximately 730 pounds of fuel, and 140 pounds of baggage and equipment in the baggage compartments. The gross weight at take-off was approximately 4480 pounds. The maximum allowable weight was 4960 pounds. A weight-and-balance computation determined that the helicopter was being operated within its load and centre-of-gravity limits.

Wreckage Examinations

The last 4 records of engine operating parameters on the helicopter performance monitoring system showed outside air temperature values of 0°C to +1°C. The recorded engine data indicated that there had been no increased power demand that might be consistent with ice building up on the airframe or rotor blades or with other anomalies. Photos of the accident site taken approximately 2 hours after the accident did not reveal any remnants of in-flight ice accumulation on any part of the aircraft.

Impact-related damage was consistent with an operating engine at the time of impact.

The warning/caution/advisory panel was examined, and it was determined that 16 bulbs had fractured filaments. Since there was sufficient force to fracture the filaments of these lamps, there should also have been sufficient force to stretch the hot filaments of any illuminated lamps. No stretched filaments were found, and all annunciators were considered to have been off at the time of impact.

The servos and the hydraulic pump were checked, and no anomalies were found. Normal operation of the flight control system is also checked before flight. The aircraft records of defects did not contain any reports of unsatisfactory hydraulic control operation.

The investigation determined that there was no airframe failure or system malfunction before or during the flight.

The single polyamide fuel tank was located within the body structure of the helicopter, behind the rear seat bulkhead beneath the engine deck. The floor structure beneath the fuel tank had given way during the impact sequence. The front half of the fuel tank was shattered, which had resulted in all of the remaining fuel exiting the helicopter downward and into the surrounding snow. The battery had been relocated to the helicopter tail boom in accordance with a supplemental type certificate (STC), which had moved it well behind and remote from the fuel tank. The high-amperage cables remained attached at the battery, at their connections beneath the rear baggage compartment floor, and from there up to the starter/generator on the overhead engine deck. The starter/generator was detached from the engine accessory gearbox; however, the wiring terminal posts and lugs were protected from arcing by insulating covers. Bundles of smaller gauge wires passed forward through the cabin floor and sidewall structures to the instrument panel, circuit breaker panels, and switch panels. These potential sources of ignition were either de-energized or did not produce enough heat to ignite a fire.

Survivability

Both seats in the pilot compartment were equipped with a 4-point restraint system. Both pilots used the full restraint system and remained restrained in their seats throughout the accident sequence. Both pilots were wearing helmets. Both pilots received head injuries. The rear passenger seat was a 4-abreast forward-facing bench seat. Each position was equipped with a 3-point restraint system. The rear-seat passenger was seated in the outer-left seat and used the lap belt and single shoulder strap. The outer lap belt was separated near the insert portion of the buckle assembly. The buckle was attached, and the passenger remained in the seat. The front windscreens were completely shattered, and the cabin was pushed back and compressed such that the floor deck had developed several creases forming an accordion shape, to a point where the occupiable cabin volume was compromised. These conditions resulted in unsurvivable injuries to all occupants.

Topography

The ravine in which the accident occurred was parallel to other ravines that cut into the western slope of the Kitsikalum River valley and formed drainages into the Kitsikalum River. Except near the bottom, there were no intersecting ravines, which meant that the only ways out of the ravine were by climbing over the ridges that formed the sides and top end at elevations of 5000–6500 feet asl or by proceeding back down the ravine to the river valley. The top end of the ravine consisted of a sparsely treed, snow-covered bowl with some dark-coloured rock outcroppings, mostly without significant definition.

Company

BHL operates a day, VFR, aerial-work and air-taxi service, using 4 different models of helicopters. The company carries out maintenance under its own approved maintenance organization. For flight operations, the company uses a Type D operational control system, under which operational control (authority over the initiation, continuation, diversion, or termination of a flight) is delegated to the pilot-in-command. The helicopter was equipped with a satellite-based tracking system for flight following and with a satellite telephone.

In accordance with section 3.2.2 of the company operations manual (COM), supported by *Canadian Aviation Regulations* (CARs) Part VII, Subparts 2, 3, and 4, an operational flight plan is required for every flight. For the subject flight, a flight itinerary was used, and flight following was carried out from the dispatch centre at the company's main base in Fort Saint John. It was noted that the flight would be out of communications range for a short time. The flight itinerary did not specify a departure time, arrival time, or search-and-rescue time.

CARs 602.115 describes the minimum visual meteorological conditions for day VFR flight in uncontrolled airspace for a helicopter operating at less than 1000 feet agl as 1-sm flight visibility and clear of cloud. CARs 703.28(2) authorizes helicopters operating in the above conditions to operate at less than 1 sm if the operator is authorized to do so by Transport Canada (TC) and complies with the Commercial Air Service Standards (CASS). Through 2 operations specifications, TC granted authority for BHL to operate to reduced visibility limits of 0.5 sm. In accordance with CASS 723.28, BHL had to meet standards for the following:

- Pilot experience;
- Reduced airspeeds;
- Pilot training, which included:
    - Pilot decision-making (the decision-making process regarding factors that affect good judgement);
    - Human performance factors describing physical, psychological, and physiological phenomena and limitations;
    - Human error countermeasures and good airmanship;
- Initial and annual recurrent flight training in procedures specified in the COM; and
- Requirements that the COM contain low-visibility operational procedures and pilot decision-making considerations regarding factors that could affect the flight.

BHL met all of these standards, and both pilots were appropriately qualified.

A safety management system (SMS) helps companies identify and manage safety risks. Part VII, Subpart 5, of the CARs requires large aircraft operators to establish, maintain, and adhere to a SMS. However, TC has postponed the requirement to implement SMS for operators of aerial-work, air-taxi and commuter services. Although not required to do so by TC regulation, BHL was in the early stages of developing a SMS and had not completed a risk assesment for low-visibility operations.

Flight Crew

The Terrace base pilot lived in Terrace and was the company assistant chief pilot and chief training pilot. This pilot (hereafter referred to as the training pilot) was seated in the front left-hand pilot seat. The training pilot had been employed with the operator since 2001, and had in excess of 8000 hours of helicopter experience, including 5000 hours of mountain-flying experience, of which 100 had been accumulated in the past 12 months. Experience on the Eurocopter AS350 consisted of 3000 hours, of which 250 had been accumulated in the last 12 months. The training pilot had completed a mountain-flying course in May 2007 and a pilot decision-making (PDM) course in October 2010, both provided by BHL. Training records indicated AS350 competencies in mountain flying, hover exit, confined-area operations, and low-visibility flying. Type ratings included BH04, BH06, BH47, HL12, HU50, RH22, RH44, and S350. The training pilot had been a delegated TC-approved check pilot since April 2011. Winter operations training was completed on 06 December 2011.

The training pilot held a Canadian commercial pilot licence (helicopter). The licence contained 1 restriction: daylight flying only. This restriction indicates that the training pilot had never received a night rating. The pilot licence had never been endorsed with an instrument rating. The licence was validated by a category 1 medical certificate valid to 01 October 2012.

Table 1. Flight and duty times of the training pilot

Flight and duty times	24 hours	72 hours	7 days	30 days	90 days
Duty time	0.0	0.0	12.0	120.0	408.0
Flight time	0.0	0.0	5.1	23.1	83.5

The training pilot had not flown for 6 days. The training pilot's non-work-related activities during the 72 hours before the accident were routine, and the training pilot typically received about 8 hours of sleep per night. The investigation did not find any indications that the pilot's performance was degraded by physiological factors including fatigue. The flight and duty times of the training pilot are shown in Table 1.

The relief pilot was the pilot receiving training and was seated in the front right-hand pilot seat, which is the designated pilot seat in the AS350. The pilot receiving training would normally be the pilot flying (hereafter referred to as the pilot). The pilot had been employed by the operator since June 2007, and had about 3000 hours of flight experience. The pilot had completed PDM training in March 2010. The pilot received an initial AS350 type rating in April 2011, provided by BHL, and training records demonstrated competencies in mountain flying, hover exit, confined-area operations, and low-visibility flying. In March 2012, the pilot had received low-visibility training, along with AS350 ground and flight training. Winter operations training was completed in March 2011. The pilot had completed a mountain-flying course in August 2011. All of the training was provided by BHL. Type ratings included BH06, EC30, HL2T, HU30, and RH44.

The pilot held a Canadian commercial pilot licence (helicopter). The licence had 1 restriction: daylight flying only. This restriction indicates that the pilot had never received a night rating. The pilot licence had never been endorsed with an instrument rating. The licence was validated by a category 1 medical certificate valid to 01 July 2012. The investigation did not find any indications that the pilot's performance was degraded by physiological factors.

Table 2. Flight and duty times of the pilot receiving training

Flight and duty times	24 hours	72 hours	7 days	30 days	90 days
Duty time	12.0	36.0	60.0	120.0	468.0
Flight time	1.4	7.1	12.7	28.1	82.8

The pilot had been on a crew rotation in Fort Nelson, British Columbia, for 9 days, and had flown 6 of those days. The pilot had not stayed in shared accommodations during the 72 hours before the accident, and was described as being well rested. The day before the accident, the pilot travelled from Fort Nelson to Fort Saint John, worked for part of the day in Fort Saint John, and arrived in Terrace at about 2130 in the evening. The duration of the pilot's sleep was not determined. The flight and duty times of the pilot are shown in Table 2.

Hover-exit Training

The AME had been in Terrace for 1 week on a regular crew rotation of 3 weeks on and 1 week off. The plan to conduct hover-exit training during this flight would have required a third person to be carried, hence the most likely reason for the AME to be on board. Section 4.20.2 of the COM lists persons allowed on board the helicopter during training. Included in this list is the AME. The company training records did not show any previous hover-exit training for the AME. Entering or leaving a helicopter in flight (hover exit) is authorized under CARs 602.25 and CARs 702.19 if the requirements in the CARs are met. Under CARs 702.19 (a)(iii), one of the requirements is that the air operator is authorized to do so in its air operator certificate. Operations specification no. 44 issued to BHL authorized the company to conduct such operations.

Pilot Decision-making

PDM is a systematic approach to managing the pilot, the aircraft, the environment, and external factors to mitigate risk. [3] In the context of an intended flight, the pilot assesses all of the elements that are present, and develops an effective plan to achieve the desired outcome: a safe flight. For the decision-making process to be successful, however, the pilot must continually reassess the conditions and determine whether the original plan is still sound, or whether a different course of action is required. Accurate and timely interpretation of the information available to the pilot is essential to the success of this process. Failure to understand a changing environment and to act accordingly may have serious consequences.

PDM is a defence against overestimating one's skill and knowledge, pushing an aircraft beyond its operating limits, and not understanding the environment and the limits it imposes on the flight. Additionally, external factors affect decision-making, such as pressure by company officials and clients/passengers, and self-imposed pressure, to complete a flight. Without PDM, pilots may find themselves in a situation that is beyond their ability to cope.

Disorientation / Loss of Control

Pilots use vision, hearing, touch, and bodily senses to establish their positions in relation to the ground. Sight is the body's most relied-upon sense, but the organs of the inner ear also play an important role in spatial orientation. Due to its design, the inner ear can mislead pilots as to their position in space. Pilots must use their vision to validate information received from the inner ear. If changes in attitude, speed, or altitude are executed gradually, the inner ear will not sense the changes immediately, and will not cue the brain to these changes. When flying with reference to outside visual cues, the pilot relies on these cues to sense changes in altitude, heading, speed, and rates of change in any axis. Changes in all 3 axes of flight can go undetected if visual cues are lost, possibly leading to a loss of control of the aircraft. [4]

A spiral dive is a steep, descending turn with the aircraft in an excessively nose-down attitude. A spiral dive may be recognized by an excessive angle of bank, rapidly increasing airspeed, and a rapidly increasing rate of descent. In general, the characteristic entry into a spiral dive begins with a slow, gentle roll, which initiates a turn that is imperceptible to the pilot. Then a descent commences, slowly at first but quickly accelerating, as the angle of bank continues to increase. When the helicopter pilot becomes aware, any action to increase collective at a steep angle of

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3 This is an overview of the pilot decision-making (PDM) process using the concepts included in the following publication: Transport Canada (TC), *Pilot Decision Making – PDM* (TP 13897, 02/2002), available at http://www.tc.gc.ca/eng/civilaviation/publications/tp13897-menu-1889.htm (last accessed on 20 November 2013).

4 Transportation Safety Board (TSB) aviation investigation report A08Q0110

bank in an effort to control the descent applies direct lift in the horizontal vector and just increases the rate of turn, further accelerating the undesired flight path. In a helicopter, any change in the collective position (lift demand) also requires a coordinated application of anti-torque pedal (to counter the corresponding change in engine power). This may add to pilot disorientation in a condition which may already involve an uncoordinated turn.

Researchers at the University of Illinois studied how long a pilot who has no instrument training can maintain control after flying into bad weather and losing visual contact. Twenty students flew into simulated instrument weather, and all went into spirals or roller coasters. The outcome differed in only one respect: the time required until control was lost. The average time was 178 seconds. [5] This finding emphasizes the importance of having some basic instrument flying skills. [6]

During the period of January 2000 through May 2012 in Canada, at least 12 occurrences involved VFR helicopter flights colliding with terrain in instrument meteorological conditions (IMC). Of those occurrences, 4 involved a loss of control at sufficient height above the surface to result in collision with terrain in an unusual attitude. These 4 occurrences involved 9 persons, 7 of whom were injured, 3 fatally.

Previously, the Transportation Safety Board (TSB) had identified a safety deficiency associated with helicopter pilot instrument flying skills. On 13 November 1990, the TSB authorized the release of the following recommendation (A90-81): [7]

> [T]he Board recommends that:
>
> The Department of Transport require verification of proficiency in basic instrument flying skills for commercially-employed helicopter pilots during annual pilot proficiency flight checks.

On 05 September 2012, the TSB issued the following Board Assessment of Response to A90-81: [8]

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5 TC, *178 seconds* (TP 2228E-1), in: TC, *Take five… for safety* (TP 2228, 01/2007), available at http://www.tc.gc.ca/eng/civilaviation/publications/tp2228-178seconds-3487.htm (last accessed on 21 November 2013)

6 TC, *Hazards Associated with Flying at Night* [PowerPoint Presentation], TP 14112, available at http://www.tc.gc.ca/eng/civilaviation/publications/tp14112-hazards-ppt-6035.htm (last accessed on 21 November 2013)

7 TSB, *Report of a Safety Study on VFR Flight into Adverse Weather* (90-SP002, 13 November 1990), available at http://www.bst-tsb.gc.ca/eng/rapports-reports/aviation/etudes-studies/90sp002/90sp002.asp (last accessed on 22 November 2013)

8 TSB, Assessment of Response to Aviation Safety Recommendation A90-81: Helicopter Commercial Pilot Licence (05 September 2012) available at http://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/1990/rec_a9081.pdf (last accessed on 21 November 2013)

TSB does not dispute TC's contention that "inadvertent" VFR into IMC events constitute a small percentage of the total VFR into IMC events. However, TSB believes that given the fatality rate of these events, TC's efforts to date to reduce the causes of VFR into IMC events are inadequate. Consequently, Recommendation A90-81 concerns itself with refreshing skills, acquired during licence training, which are designed to assist pilots in extracting themselves from a VFR into IMC event. The fact that the majority of VFR into IMC events may be preceded by poor pilot decision making does not diminish the value of maintaining piloting skills intended to deal with such an event.

TC's response is critical of the 180-degree-turn procedure which is outlined in its TP9982E *Helicopter Flight Training Manual*. TC explains that, due to a combination of an unstabilized helicopter, a panicked pilot and the inherent difficulty in transitioning to instruments, the successful use of the 180-degree-turn procedure is unlikely. TC's response suggests that this VFR into IMC situation is exacerbated by the pilot being "without any recency in instrument flight". TSB understands that the instrument flying instruction as conducted during licence training does not qualify any pilot to fly IFR. However, the training emphasizes that the recommended 180-degree-turn procedure is to be used in an emergency and is characterized as the "safest and most expedient procedure" to transition back to VMC.

TC states that because Canadian regulations do not require day VFR aircraft to be equipped with the instruments necessary to safely fly in IMC, all such aircraft would need to be upgraded to accomplish manoeuvres such as a 180-degree turn. It concludes that implementing Recommendation A90-81 would be prohibitively expensive. TSB appreciates that the instrument flying taught during licence training is designed for a pilot who encounters a VFR into IMC event while flying a helicopter not suitably instrumented for IFR flight. The "basic instrument flying skills", referred to in Recommendation A90-81, are those taught during licence training which does not require use of an IFR equipped helicopter. Therefore, a universal upgrade of the current day VFR helicopter fleet would not necessarily be required to implement Recommendation A90-81.

TC's comparison between the U.S. and Canadian commercial helicopter experience operating under VFR into IMC focuses on the limitations of the U.S. air ambulance and a regional sightseeing phenomenon. The FAA's NPRM, referred to in TSB's assessment, is entitled *Air Ambulance and Commercial Helicopter Operations*, and the two referenced NTSB recommendations calling for enhanced training for commercial helicopter pilots resulted from accidents under flat light conditions involving commercial helicopters.

While TC believes there is value in including an instrument flying exercise as part of the licence training, its current analysis sees no benefit in enhancing recurrent training in the manner described in Recommendation A90-81. While it has stated a concern for the fact that 50% of VFR into IMC accidents result in fatalities, it maintains that the status quo in mitigating these risks is the obvious and most effective means of preventing these accidents.

Currently, the risks associated with VFR flight into adverse weather remain substantial and TC has not indicated it plans any action to reduce the risks associated with allowing a non-instrument rated commercial helicopter pilot's basic instrument flying skills to deteriorate as described in Recommendation A90-81. Consequently the reassessment remains as Unsatisfactory.

Next TSB Action (05 September 2012):

The Board has determined that as the residual risk associated with the deficiency identified in Recommendation A90-81 is substantial and because no further action is planned by TC, continued reassessments likely will not yield further results.

The deficiency file is assigned a Dormant status.

Flight Recorders

This helicopter was not equipped with any on-board recording devices, such as a cockpit voice recorder (CVR) or flight data recorder (FDR), nor was this equipment required by regulation.

There were no witnesses to the occurrence. Information gathered from the helicopter performance monitoring system, GPS tracking system, portable GPS, and personal cameras greatly assisted the TSB investigation.

Emergency Locator Transmitter

The helicopter was equipped with a Kannad 406 AF-Compact emergency locator transmitter (ELT). The ELT activated and transmitted a 406-MHz signal, which was received by the Canadian Mission Control Centre.

Transportation Safety Board Laboratory Reports

The following TSB Laboratory reports were completed:

- LP111/2012 − GPS Analysis
- LP125/2012 − Annunciator Lamp Analysis (Includes Artificial Horizon)

These reports are available from the TSB upon request.

Analysis

The aircraft systems were examined, and no indication of a malfunction was found. The pilots were both experienced, and the training pilot had knowledge of the local area. Neither fatigue nor physiological factors were considered contributory. Therefore, this analysis will focus on the events, conditions, and underlying factors that caused or contributed to pilot decision-making (PDM).

The training flight occurred when it did because it was the only opportunity for the relief pilot to receive some additional mountain-flying and hover-exit training, along with a familiarization flight in the local area, before the training pilot left for vacation. It is unusual for a third person to be on board a pilot training flight. However, given the intent to include hover-exit training, someone was required to perform the exit and entry while the helicopter was in a hover, and there were only 3 company personnel at the Terrace base.

Weather / Low-visibility Operations

The Terrace weather conditions and forecasts were suitable for a visual flight rules (VFR) flight. The pilots were likely aware that the forecast indicated temporary restrictions to ceiling and to visibility and potential airframe icing conditions for the area.

As the helicopter climbed, the nature of the snow-covered terrain near the top end of the ravine would have provided fewer and fewer visual references to aid in a pilot's depth perception. It is probable that the mountain ridges were obscured by overcast ceilings, resulting in whiteout conditions of flat lighting and little or no horizon reference. The records of the flight path indicate a right-hand turn commencing at 4500 above sea level (asl) as a steady, uniform arc, which is consistent with the flight path of an aircraft entering a spiral dive. The relatively low engine power demand and the lack of any indication of icing on the airframe following the accident suggest that airframe icing was not a factor.

The company and the pilots were authorized to conduct low-visibility operations in uncontrolled airspace. By approving this exception, Transport Canada (TC) authorizes VFR flight operations in instrumental flight conditions (IMC) at reduced visibilities. Many helicopter operators hold this operations specification, and it is usually applied as an operating standard. In accordance with the conditions of that authorization, Bailey Helicopters Limited (BHL) had policies, procedures, and training in place to serve as defences against weather-related risks. The required pilot training is primarily aimed at PDM skills as a method of avoiding a loss of visual reference. Minimum VFR weather conditions include a minimum visibility requirement as a safety defence against a loss of visual reference.

Operating in conditions with visibility reduced to 0.5 statute miles (sm) increases the risk of inadvertent loss of reference. The low-visibility operations specification allows the visibility to be reduced from 1 sm to 0.5 sm, provided that the pilot has appropriate experience and training and that the helicopter is operated at reduced speed. But it does not require instrument flight proficiency for pilots or the use of aircraft certified for flight in IMC. Research and statistics show that without basic instrument flight training and proficiency, the average time to loss of control for VFR pilots can, in most cases, be measured in minutes.

Currently, the risks associated with VFR flight into adverse weather remain substantial, and TC has not indicated that it plans any action to reduce the risks associated with allowing a non-instrument-rated commercial helicopter pilot's basic instrument flying skills to deteriorate as described in Recommendation A90-81.

Pilot Decision-making

In accordance with the company operations manual (COM), the reduction in ground speed as the helicopter climbed up the ravine could indicate that poor visibility conditions were encountered. However, continuing to climb at 1000 feet per minute (fpm) is not consistent with that hypothesis. The records of the flight path show that the helicopter maintained a relatively steady height above the terrain directly below, but the engine parameters did not indicate that the pilot was demanding any of the excess power available to out-climb the terrain gradient. The rate of climb to 4500 asl would suggest that the pilots did not assess the conditions they were in as being particularly hazardous. However, the quick level-off at 4500 feet, coincident with initiating a right-hand turn, would suggest that conditions changed, and could indicate that the pilots unexpectedly lost sight of the ground. As soon as sight of the ground is lost, the pilot's priority would be to regain visual reference by descending, turning, or both, while maintaining control of the helicopter. The subsequent flight path of the helicopter indicates that a turn and slow descent was attempted. But during this manoeuvre, the non-instrument-trained pilot flying became disoriented, lost control of the helicopter, and collided with the snow-covered terrain.

Fire

The remote location of the aircraft battery in the tail boom, combined with the routing of high amperage cables behind and over the cabin, likely mitigated the risk of ignition of the spilled fuel.

Findings

Findings as to Causes and Contributing Factors

1. The helicopter likely entered instrument meteorological conditions, resulting in the pilot losing visual reference with the ground and becoming disoriented, which resulted in a loss control of the helicopter and collision with terrain.

2. Neither pilot held an instrument rating or had any recent instrument flight training, nor was the helicopter equipped for instrument flying, which contributed to the loss of control of the helicopter while flying in instrument meteorological conditions.

Findings as to Risk

1. Operating in conditions with visibility reduced to 0.5 statute miles increases the risk of inadvertent loss of visual reference.

Other Findings

1. The remote location of the aircraft battery in the tail boom, combined with the routing of high amperage cables behind and over the cabin, likely reduced the risk of ignition of the spilled fuel.

Safety Action Taken

Bailey Helicopters Limited

Bailey Helicopters Limited (BHL) have made the following changes:

- Suspended the use of its Transport Canada-issued Operations Specification that allows low-visibility operations
- Developed and implemented a pre-flight risk assessment that must be completed before all flights
- Developed a flight-training policies and procedures manual (essential crew only for all training flights)
- Implemented a flight data monitoring system
- Purchased an Astar flight simulator, with a main focus on controlled flight into terrain (CFIT) and inadvertent meteorological condition training
- Added a CFIT training course to its annual ground school
- Created a quality assurance position within the flight operations department
- Implemented human factors training, which includes annual decision-making workshops and crew resource management for flight and maintenance personnel
- Increased standard operating procedures to 1-mile visibility, 500-foot ceiling, and clear of cloud
- Continued to educate its customers in the risk of flying in low-level or low-visibility operations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 November 2013. It was officially released on 03 December 2013.