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

# AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A22P0111

**COLLISION WITH TERRAIN**

Geotech Aviation Ltd.
Airbus Helicopters AS350 B3, C-FVCR
Kitsault, British Columbia, 2 NM SSW
09 November 2022

Canada

## ABOUT THIS INVESTIGATION REPORT

This report is the result of an investigation into a class 3 occurrence. For more information, see the Policy on Occurrence Classification at www.tsb.gc.ca

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.

## TERMS OF USE



**Citation**

Transportation Safety Board of Canada, *Air Transportation Safety Investigation Report* A22P0111 (released 25 September 2024).

Transportation Safety Board of Canada
200 Promenade du Portage, 4th floor
Gatineau QC  K1A 1K8
819-994-3741; 1-800-387-3557
www.tsb.gc.ca
communications@tsb.gc.ca



Air transportation safety investigation report A22P0111

Cat. No. TU3-10/22-0111E-PDF
ISBN 978-0-660-73612-9

This report is available on the website of the Transportation Safety Board of Canada at www.tsb.gc.ca

*Le présent rapport est également disponible en français*.

# Table of contents

# AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A22P0111

**COLLISION WITH TERRAIN**

Geotech Aviation Ltd.
Airbus Helicopters AS350 B3, C-FVCR
Kitsault, British Columbia, 2 NM SSW
09 November 2022



## Summary

At 0911 Pacific Standard Time on 09 November 2022, the Geotech Aviation Ltd. Airbus Helicopters AS350 B3 helicopter (registration C-FVCR, serial number 4434) departed from a staging area at Kitsault, British Columbia, for a visual flight rules flight with only the pilot on board to conduct an airborne geophysical survey over mountainous terrain. The helicopter flew to the survey area that was located approximately 12 nautical miles south-southwest of the staging area. Following approximately 1.5 hours of flying and 6 low-level survey passes, the pilot reported feeling unwell and stated that he was returning to the staging area earlier than scheduled. The helicopter did not arrive at the staging area, and an emergency locator transmitter signal was received by the Joint Rescue Coordination Centre in Victoria, British Columbia at 1118.

The occurrence helicopter was located by a search and rescue aircraft 2 nautical miles south-southwest of the staging area, on a heavily forested mountainside. The pilot received fatal injuries. The occurrence helicopter was destroyed.

# 1.0 FACTUAL INFORMATION

## 1.1 History of the flight

On 09 November 2022, the Geotech Aviation Ltd. (Geotech) Airbus Helicopters AS350 B3 helicopter was conducting an airborne geophysical survey in the vicinity of Kitsault, British Columbia (BC). The helicopter staging area was located in Kitsault, and the survey area was approximately 12 nautical miles (NM) to the south-southwest, in mountainous terrain.

At approximately 0745,[1] the occurrence pilot checked the weather at the crew house and determined that it was safe for survey flight operations. The pilot and the geophysical equipment operator[2] drove 1.2 km to the helicopter staging area. Using a fuel tank located there, the pilot refuelled the helicopter for approximately 2.5 hours of flight.

The helicopter departed the staging area at 0911 on a visual flight rules survey flight with only the pilot on board. Connected to the helicopter was the 680-pound survey equipment that was suspended 140 feet below the helicopter's cargo hook. The helicopter arrived at the survey area 13 minutes later, and the pilot flew 6 low-level survey passes, which were each approximately 7.5 NM long, over the mountainous and varying terrain.

At approximately 1045, following the last survey pass, the pilot departed the survey area to begin the return flight to the staging area. He climbed to approximately 3900 feet above ground level (AGL) and pressed the "BIN" button on a remote keypad to save the survey data to the survey computer's hard drive.

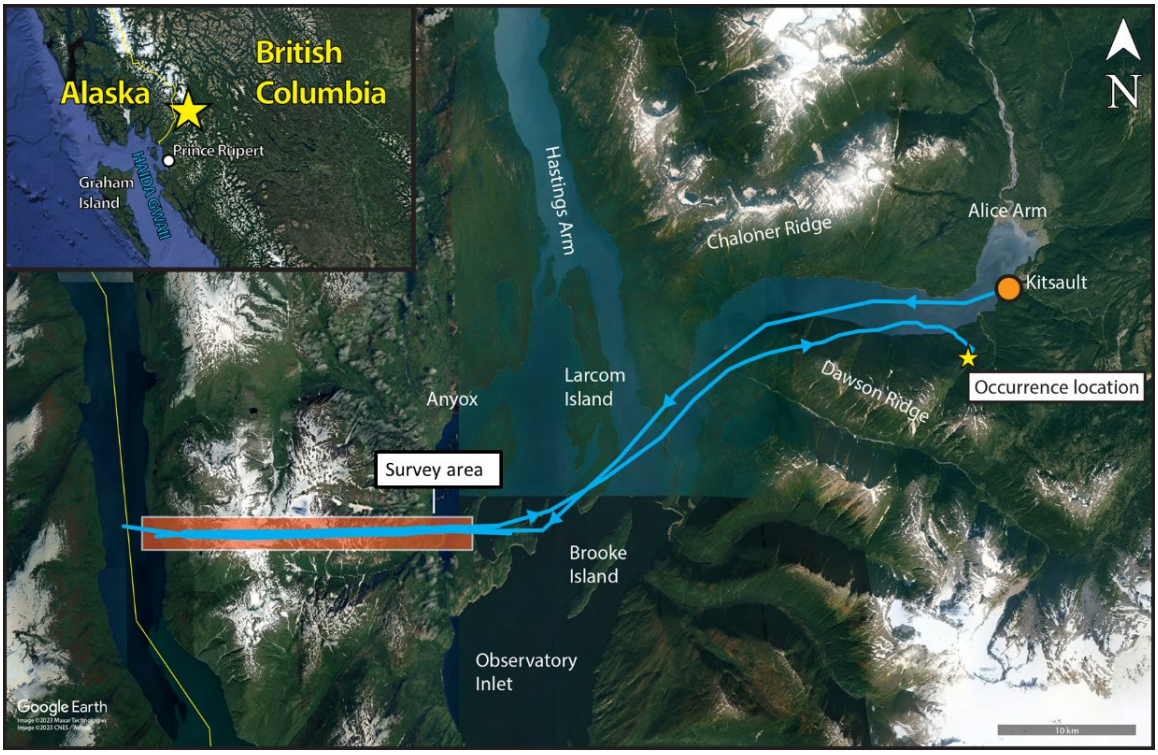
During the return flight, the pilot radioed the geophysical equipment operator on a very high frequency (VHF) FM radio and reported that he was unwell and shivering uncontrollably. He indicated that he would be returning to the staging area (Figure 1). This radio call was made approximately 1 hour earlier than the scheduled return time. At 1055:22, the pilot pressed the emergency button on the aircraft flight-tracking system.

---

1 All times are Pacific Standard Time (Coordinated Universal Time minus 8 hours).

2 The geophysical equipment operator's role is to process and analyze the survey data, test and repair the survey equipment, and take part in survey flights if deemed necessary by the pilot and operator.

**Figure 1. Flight track for the occurrence flight, showing the outbound leg, from Kitsault to the survey area, and the inbound leg, from the survey area to the occurrence location (Source: Google Earth, with TSB annotations)**




At the crew house, the geophysical equipment operator checked the flight-tracking web application used by Geotech and saw that the helicopter was 5.4 NM from the staging area, with an estimated arrival time in approximately 10 minutes. He drove to the staging area to meet the helicopter and arrived at 1101. The helicopter was not visible from the staging area, but it could be heard operating with a variable sound. At approximately 1111, the helicopter sound stopped abruptly, and at 1112, an emergency locator transmitter (ELT) signal was received by the Joint Rescue Coordination Centre (JRCC) in Victoria, BC.

The helicopter never arrived at the staging area. The geophysical equipment operator contacted Geotech's director of operations, and the company emergency response plan was activated. The director of operations contacted a commercial helicopter operator in Terrace, BC, and 1 helicopter was dispatched to the scene to begin the search. In addition, the JRCC dispatched 1 search and rescue Cormorant helicopter and 1 search and rescue Hercules airplane. During the search, the commercial helicopter landed at the staging area to refuel. Fuel samples were taken from the bowser before refuelling, and there was no contamination reported or recorded.

Less than 4 hours later, at 1502, the occurrence helicopter was located by the Hercules airplane 2 NM south-southwest of the staging area on a heavily forested mountainside. The search and rescue technicians were lowered from the Cormorant helicopter and determined that the pilot had been fatally injured. The occurrence helicopter was destroyed.

## 1.2 Injuries to persons

The pilot was alone on board. Table 1 outlines the degree of injuries received.

**Table 1. Injuries to persons**

| Degree of injury | Crew | Passengers | Persons not on board the aircraft | Total by injury |
|---|---|---|---|---|
| Fatal | 1 | – | – | 1 |
| Serious | 0 | – | – | 0 |
| Minor | 0 | – | – | 0 |
| Total injured | 1 | – | – | 1 |

## 1.3 Damage to aircraft

The helicopter was destroyed.

## 1.4 Other damage

Unknown amounts of aircraft fuel, engine and gearbox oils, and hydraulic fluid were released onto the ground.

## 1.5 Personnel information

**Table 2. Personnel information**

| | |
|---|---|
| Pilot licence | Commercial pilot licence – helicopter |
| Medical expiry date | 01 January 2023 |
| Total flying hours | 18 825.4 |
| Flight hours on type | 12 992.9 |
| Flight hours in the 24 hours before the occurrence | 2.0 |
| Flight hours in the 7 days before the occurrence | 7.3 |
| Flight hours in the 30 days before the occurrence | 29.6 |
| Flight hours in the 90 days before the occurrence | 97 |
| Flight hours on type in the 90 days before the occurrence | 97 |
| Hours on duty before the occurrence | Approximately 3.5 |
| Hours off duty before the work period | 88 |

The occurrence pilot held the appropriate licence and rating for the flight in accordance with existing regulations.

The pilot held a commercial pilot licence – helicopter with a valid Category 1 medical certificate. His pilot competency check for the AS350 series of helicopters was valid until 01 April 2023. The pilot joined Geotech in 2018 and his company indoctrination training, as well as his technical ground and flight training, were up to date. The training included specialty flight operations involving long lines and aerial survey equipment towing.

The pilot had 27 days free from duty before travelling to Kitsault on 28 September 2022 to start his work assignment. Despite the fact that the pilot was on day 43 of his assignment on the date of the occurrence, the weather conditions during his assignment had not been favourable for geophysical survey flights, and he consequently had flown only 13 days during the assignment. The last flight (a non-survey flight) was on 05 November 2022.

According to Geotech's operations manual, the pilot "shall receive at least 5 consecutive periods o[f] 24 consecutive hours free from all duty following any assignment that exceeds 30 consecutive days."[3] The pilot had 9 consecutive days without flight duties, from 23 October to 31 October 2022, due to inclement weather. In addition, he and the company director of operations agreed to an extension to the pilot's shift in Kitsault, during which they would monitor for fatigue. At the time of the occurrence, the Kitsault project was 72% complete, with approximately 5 days of flying remaining.

The day before the occurrence, the pilot felt unwell and rested for much of that day; however, the following morning he reported feeling well enough to fly. Based on a review of the pilot's work and rest schedule, there was no indication that the pilot's performance was degraded by fatigue.

## 1.6 Aircraft information

The AS350 B3 helicopter is a 3-bladed, intermediate single-engine helicopter powered by a Turbomeca Arriel 2B1 turboshaft engine. The occurrence helicopter was purchased in South Africa and imported into Canada, receiving a certificate of airworthiness on 21 December 2020 with 4175.4 hours total airframe time (Figure 2).

[3] Geotech Aviation Ltd., *Aerial Work/Air Taxi Operations Manual*, Amendment No. 9 (30 November 2014), Part 1, Chapter 4: Operational Control, Section 4.15.4: Minimum Rest and Time Free From Duty, p. 4-21.

**Figure 2. Occurrence helicopter (Source: Ian Boychuck, with permission)**


During importation, the helicopter was partially disassembled and underwent the 144-month inspection during which all applicable airworthiness directives and service bulletins were reviewed and completed as required. The engine was replaced with a newly overhauled engine and hydromechanical fuel metering unit. The aircraft was repainted, reweighed, and placed into service following dynamic balancing of the tail rotor driveshaft, tail rotor, and main rotor.

The helicopter was maintained in accordance with the company maintenance schedule that was approved by Transport Canada (TC). The last inspection recorded in the journey logbook was on 22 October 2022 (15.0 logged hours before the occurrence) and consisted of a 150-hour/12-month airframe and engine inspection, the completion of multiple airworthiness directives and service bulletins, a tail gearbox oil change, and a starter generator inspection. The last engine power check was conducted 3.3 logged hours before the occurrence, and there were no abnormal indications or trends.

There were no recorded defects outstanding at the time of the occurrence.

**Table 3. Aircraft information**

| | |
|---|---|
| Manufacturer | Eurocopter* |
| Type, model, and registration | AS350 B3, C-FVCR |
| Year of manufacture | 2008 |
| Serial number | 4434 |
| Certificate of airworthiness issue date | 21 December 2020 |
| Total airframe time | 5220.0 hours |
| Engine type (number of engines) | Turbomeca Arriel 2B1 (1)** |
| Rotor type (number of rotor blades) | Semi-rigid (3) |
| Maximum allowable take-off weight | 4961 lb (2250 kg) |
| Recommended fuel types | Jet A, Jet A-1 |

| | |
|---|---|
| Fuel type used | Jet A-1 |

* Airbus Helicopters currently holds the type certificate for the aircraft type.
** The type certificate holder changed from Turbomeca to Safran Helicopter Engines on 01 August 2016.

There was no indication that a component or system malfunction played a role in this occurrence.

### 1.6.1 Weight and balance

At the time of the occurrence, the helicopter's basic empty weight was based on the configuration for the Versatile Time Domain Electromagnetic (VTEM)[4] survey equipment system and included an auxiliary fuel tank, cargo hook assembly, landing gear bearpaws, and emergency floats.

The investigation was unable to determine the quantity of fuel on board the helicopter at the time of the occurrence and, as a result, could not determine the weight and balance of the helicopter.

### 1.6.2 Cargo hook

The occurrence helicopter was equipped with an Onboard Systems International Talon LC Keeperless cargo hook that was mounted on a cargo swing suspended from the belly of the helicopter. The cargo hook had a maximum lifting capacity of 3500 pounds, but the cargo swing was limited to a maximum capacity of 3086 pounds.

The cargo hook incorporates both an electrical and a mechanical (cable-actuated) release system, which are pilot-activated by using a switch located on the cyclic and a lever located on the collective, respectively. When either system is activated, the cargo hook load beam assembly rotates open and away from the cargo hook body, allowing the load to slide off of the load beam and detach from the helicopter.

### 1.6.3 Survey equipment

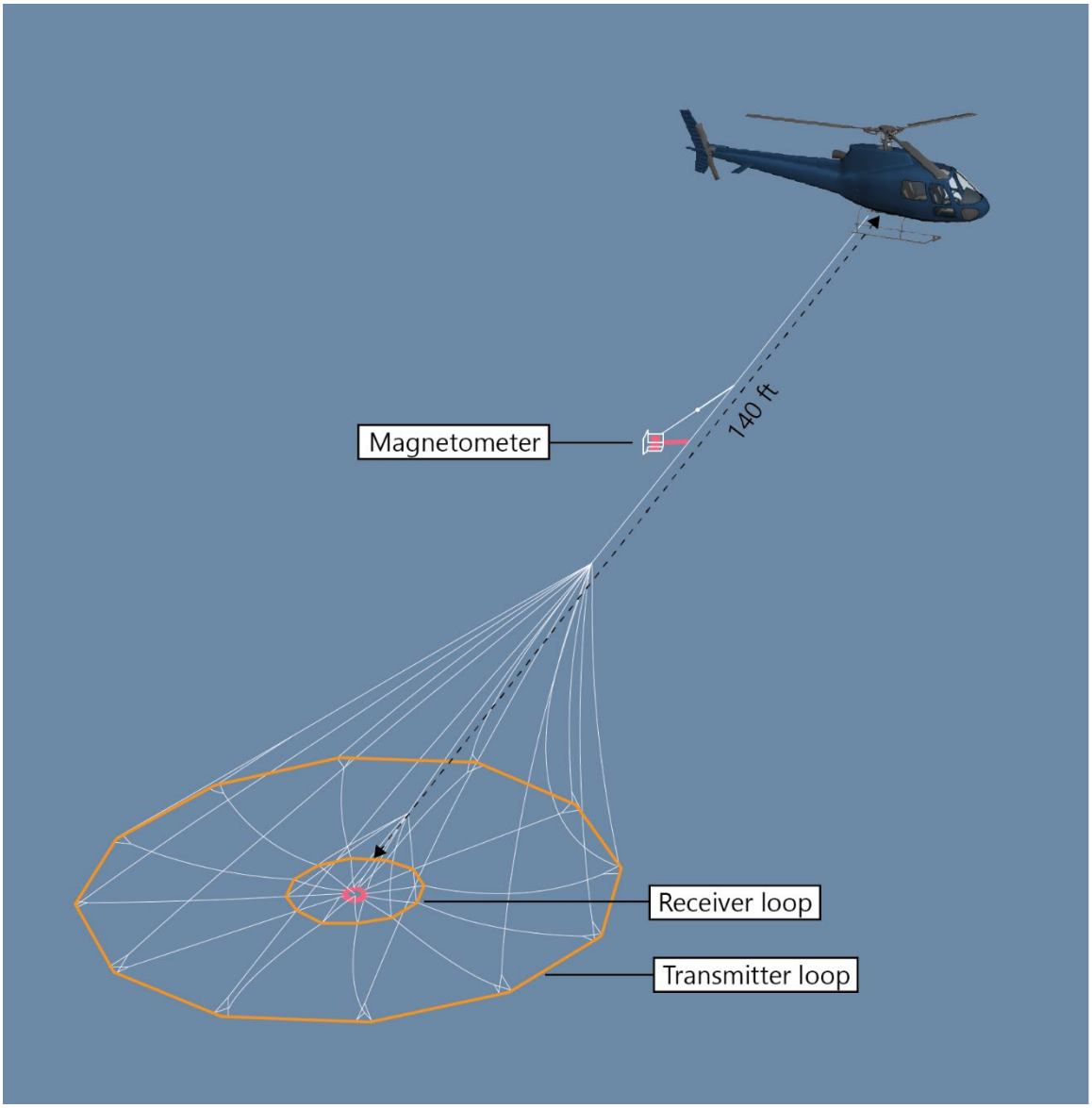
The occurrence helicopter was carrying the VTEM Terrain system to survey for mineral deposits on behalf of a third-party mining exploration and development company. The VTEM Terrain system consisted of a central processing unit secured behind the pilot seat, 2 monitors to the left of the pilot seat, a keypad on top of the instrument panel, and an in-loop transmitter-receiver assembly that was carried below the helicopter. The VTEM Terrain assembly weighed 680 pounds on the cargo hook.

The transmitter-receiver assembly consisted of 2 loops: the transmitter loop, which is 58 feet in diameter, and the receiver loop, which is 15 feet in diameter. Both loops are constructed of composite tubing segments and suspended 140 feet below the helicopter cargo hook with a combination of a steel braided cable (called a weak link), a 70-foot long

[4] Geotech Ltd., a sister company of Geotech Aviation Ltd., holds the worldwide patent and trademark for the VTEM survey equipment system, including its exclusive design.

line, 2 bungee cords, and multiple small-diameter ropes. A magnetometer was attached to the long line 43 feet below the hook (Figure 3).

**Figure 3. Graphic illustration of the Versatile Time Domain Electromagnetic Terrain assembly suspended below the helicopter on the cargo hook (Source: TSB)**




The weak link connected the long line to the helicopter cargo hook and was held in place by 2 clevises, 1 at either end. The weak link was approximately 2 feet long, constructed of $^{3}/_{16}$-inch steel cable, and designed to break when a 4100- to 4800-pound force is applied, such as if the loops are snagged on an object.

## 1.7 Meteorological information

The nearest aviation weather reporting station to the occurrence site is Stewart Aerodrome (CZST), BC, which is located 34 NM north-northwest of the occurrence site. The aerodrome routine meteorological report (METAR) for CZST issued at 1100 and valid at the time of the occurrence indicated the following:

- Winds from 30° true (T), variable in direction from 350°T to 60°T at 4 knots
- Visibility 14 statute miles
- Scattered cloud layers at 10 000 feet and 20 000 feet AGL
- Temperature −5 °C, dew point −14 °C
- Altimeter setting 30.24 inches of mercury

The geophysical equipment operator submitted a weather report for each day of airborne survey flights. On the day of the occurrence, the report at 1010 indicated that local conditions were overcast with a temperature of −6 °C and winds from the east at 3 knots gusting 14 knots.

From the data collected, the investigation noted that the pilot successfully surveyed terrain for approximately 80 minutes before the occurrence. Weather was not considered to be a factor in his decision to return early to the staging area, nor was it considered to be a factor in this occurrence.

## 1.8 Aids to navigation

Not applicable.

## 1.9 Communications

The geophysical equipment operator was equipped with a handheld FM radio so that he could, from the staging area, communicate with the pilot during local flights conducted for the purpose of testing the survey equipment and during the inbound and outbound legs of the survey flights. Typically, the operator was unable to communicate with the pilot while the pilot flew at the survey site because of the site's distance from the staging area, the mountainous terrain, and the efficacy of the radio.

Although reception was degraded, the final radio transmission from the pilot was audible and received by the equipment operator. However, the investigation was unable to determine the helicopter's location at the time of the transmission.

## 1.10 Aerodrome information

Not applicable.

## 1.11 Flight recorders

The helicopter was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

However, the helicopter was equipped with a Guardian Mobility Flightcell DZMx satellite and cellular flight-tracking unit that was mounted on the instrument panel and provided information about the flight path. The tracking data was normally transmitted at 2-minute intervals and was available to Geotech personnel through a web-based application called

SilverEye Aviation.[5] The equipment operator had access to the web application and provided flight following from Kitsault.

The flight-tracking unit was equipped with an emergency button (EMER) that was located on the front of the unit and within the pilot's reach. When activated, the EMER mode reduces the tracking-reporting intervals from 2 minutes to 1 minute and causes "Emergency Mode!" to flash at the bottom of the tracker display in the aircraft. In addition, the SilverEye Aviation web application will display a "Distress" tag under the aircraft registration, create a pop-up window in the bottom right corner of the map screen, and send a distress alert via email or text messages if the company using the unit selects each of these options. Geotech indicated that the text and email messaging option had been activated to notify select company personnel.

During the inbound leg of the occurrence flight, the pilot pressed the EMER button on the tracker 16 minutes before the occurrence, as indicated by the manufacturer's tracking data. Geotech personnel reported that no messages were received and that they noticed nothing abnormal on the web application. Following the occurrence, investigators reviewed a screenshot of the web application map image and noted that the helicopter was tagged as "distress" in the aircraft listing table on the lower left corner of the screen.

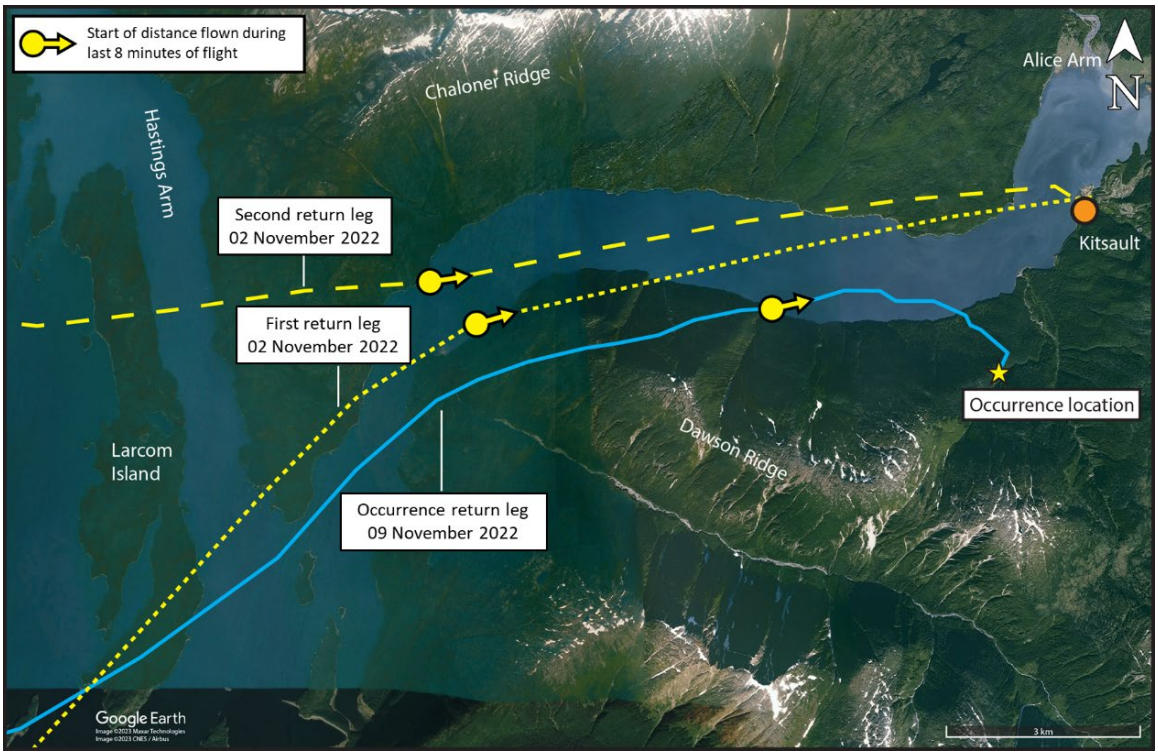
Geotech had conducted the annual inspection of the flight tracker on 11 December 2021, and no faults were recorded at that time.

The investigation compared the inbound leg on the occurrence flight to the last 2 inbound legs flown by the occurrence pilot 7 days beforehand (Figure 4) and found the following differences on the occurrence inbound leg:

- The flight track began to meander approximately 8 minutes before the occurrence and turned approximately 60° away from the staging area.
- The average speed recorded for the last 8 minutes on the inbound leg of the occurrence flight was 14.2 knots versus an average of 40.4 knots and 39.2 knots on the previous 2 inbound legs.
- The speed fluctuated throughout the entire inbound leg of the occurrence flight with a minimum speed of 5.8 knots and a maximum speed of 46.6 knots.

5 SilverEye Aviation is the web-based application platform provided by Guardian Mobility.

**Figure 4. Flight tracks for the last 3 inbound legs to Kitsault flown by the occurrence pilot, with the segments flown during last 8 minutes of flight indicated (Source: Google Earth, with TSB annotations)**




The investigation also collected the survey track data for the occurrence flight from the survey data card, but the survey equipment did not record the last 20 minutes (approximately) of the inbound leg and had likely been switched off by the pilot.

Although the availability of the satellite tracking data provided significant information for this investigation, the aircraft's exact manoeuvring during the final moments of the flight and the elapsed time between the final recorded data point and the actual impact with the terrain could not be determined.

### 1.11.1 Previous TSB recommendation

Following a fatal accident with no survivors or witnesses, an investigation may never be able to determine the exact causes and contributing factors unless the aircraft is equipped with an on-board recording device. The benefits of recorded flight data in aircraft accident investigations are well known and documented.[6]

---

6 TSB air transportation safety investigation reports A21O0056, A20P0080, A19P0187, A19P0176, A18P0080, A17P0170, A16A0032, A15P0081, A14Q0148, A14W0127, A13H0002, A12W0031, A12C0005, A11H0001, A11P0106, A11C0047, A11W0048, A11O0031, A11Q0028, A11P0117, A10P0244, A09P0187, A09A0036, A07W0150, A07Q0063, A06W0139, A05C0187, A05W0137, A03H0002, A02W0173, and A01W0261.

Following an occurrence[7] on 13 October 2016 in which a privately operated Cessna Citation 500 collided with the ground and fatally injured the pilot and 3 passengers, the Board recommended that

> the Department of Transport require the mandatory installation of lightweight flight recording systems by commercial operators and private operators not currently required to carry these systems.
>
> **TSB Recommendation A18-01**

In its December 2023 response to this recommendation, TC indicated that it agreed in principle with this recommendation and had published a Notice of Proposed Amendment (NPA) in December 2021 that proposed changes to the regulation mandating the installation of lightweight data recorders (LDRs) in existing and newly manufactured aircraft. TC received significant industry input and comments that resulted in a reassessment of the approach and scope of the LDR requirements. TC is developing a new and revised NPA, which was planned to be published in early 2023, with proposed regulation amendments to be published in the *Canada Gazette*, Part I in early 2024. However, in this most recent response, TC has indicated that the date for the NPA to be published has been extended into 2024-25 to allow for additional analysis. The timeline for publication of the proposed regulatory amendments in the *Canada Gazette*, Part I was not specified.

In its February 2024 assessment of TC's response, the Board stated that it remains concerned by the potential change in approach and scope of the LDR requirements and the lengthy delays in implementation. Until the revised NPA is available for review, it is unknown if the previously proposed requirements will be preserved.

Therefore, the Board was unable to assess TC's response to Recommendation A18-01.[8]

## 1.12 Wreckage and impact information

The helicopter wreckage was located in steep and heavily treed terrain approximately 0.25 NM south of the last known position indicated by the helicopter's flight tracker.

### 1.12.1 Main rotor blades

The 3 main rotor blades were destroyed and found in different locations.

One rotor blade was suspended in a tree approximately 48 feet off the ground, and the tree had a portion of its bark removed along with several impact markings near the blade. The blade had significant brown discoloration and abrasion damage. Rotor blade skin and foam core fragments were found scattered in the area surrounding the tree.

---

7 TSB Aviation Investigation Report A16P0186.

8 TSB Recommendation A18-01: Mandatory installation of lightweight flight recording systems, at https://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/2018/rec-a1801.html (last accessed on 07 July 2024).

The second and third rotor blades were located near the fuselage. The second blade had broken in a forward direction approximately halfway down its length, and the third blade was the only blade still partially connected to the main rotor head.

### 1.12.2 Fuselage

The fuselage had come to rest pointing downhill and inverted on top of another tree, which had fallen during the impact sequence and had crushed the helicopter's canopy. The tail boom had separated from the fuselage at the tail boom junction. The right skid tube had separated from the fuselage whereas the left skid tube had remained attached to the fuselage by the aft cross tube and was pointing uphill.

### 1.12.3 Tail boom and rotor

The tail gearbox with the tail rotor assembly remained installed on the tail boom. The pitch links were connected to the pitch change spider, and the tail rotor control rod was fractured at the tail boom junction. The aft section of the tail rotor driveshaft remained on the tail boom and partially connected to the gearbox.

### 1.12.4 Other components

The main gearbox and engine had been ejected from the fuselage and were located approximately 24 and 46 feet downhill, respectively. Both components remained largely intact, and part of the main rotor head remained attached to the gearbox.

The cargo hook remained attached to the cargo swing, and the assembly remained intact with the swing cables attached to all 4 mounting points on the fuselage.

The survey antenna loops and the associated magnetometer and long line were no longer attached to the cargo hook. They were located approximately 135 feet uphill of the fuselage and suspended in multiple trees and branches over approximately 63 feet.

### 1.12.5 Examination of the engine

Investigators carried out a visual examination of the helicopter engine and recovered the digital engine control unit (DECU) from the wreckage. The engine manufacturer assisted staff from the TSB Engineering Laboratory to download the data from the DECU memory. Based on the engine examination and the DECU data review, investigators determined that there were no engine faults related to the occurrence flight and no historical faults that indicated a systemic or recurring engine issue.

### 1.12.6 Cargo hook examination

The cargo hook mechanical release cable was found intact and still connected to the lever on the helicopter collective.

Following the recovery of the aircraft, investigators tested the mechanical release by actuating the lever on the collective; the mechanical release functioned normally, and the

load beam rotated open as designed (figures 5 and 6). Given the damage to the electrical system, the electrical release system could not be tested on the helicopter.

**Figure 5. Cargo hook from the occurrence helicopter in the closed position (Source: TSB)**

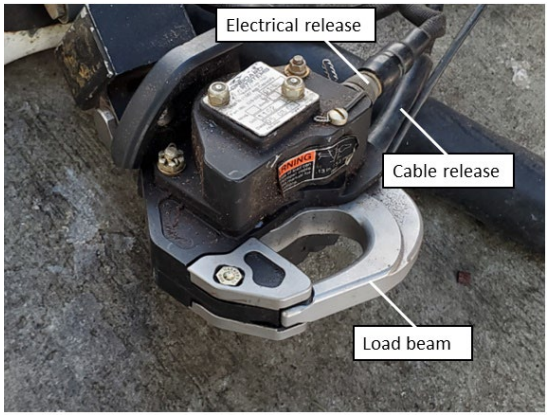



**Figure 6. Cargo hook from the occurrence helicopter in the open position, after the mechanical (cable) release lever had been actuated (Source: McLarens Aviation)**

The cargo hook was removed from the helicopter and additional testing was conducted on the release system in accordance with the Acceptance Test Procedure[9] outlined in the component maintenance manual. The cargo hook release system operated normally and was not a factor in this occurrence.

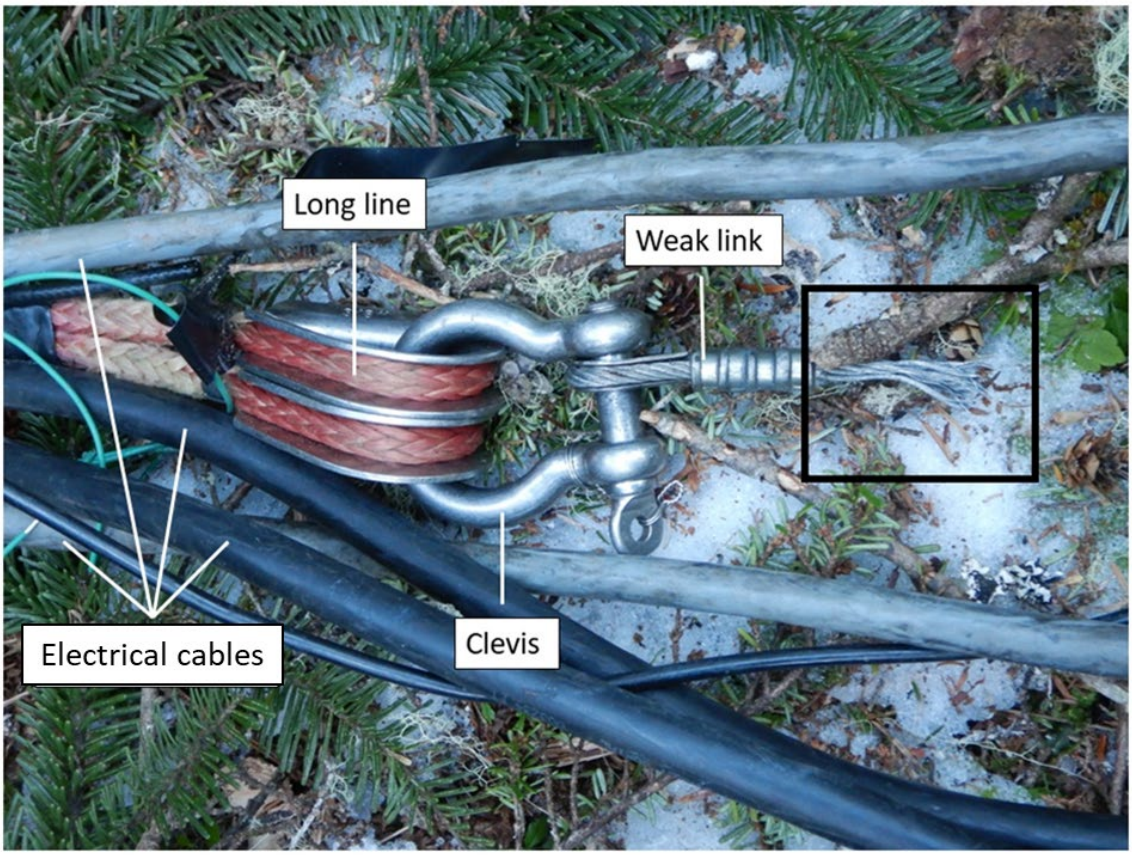
### 1.12.7 Survey loops and associated rigging

Investigators examined the survey loops, magnetometer, and associated rigging and found that the weak link remained attached to the long line with the lower clevis and that the cable was broken on the other side of the cable crimp (Figure 7). The other part of the cable and the other clevis were not recovered.

The electrical cables between the helicopter and the survey equipment were found disconnected at the connectors near the fuselage.

9 Onboard Systems International, LLC, *Component Maintenance Manual, Cargo Hook*, Document Number 122-005-00, Rev. 36 (22 December 2022), Section 10: Acceptance Test Procedure, p. 28.

**Figure 7. Long line, electrical cables, and weak link found at the occurrence site, with the broken steel cable of the weak link highlighted in black square (Source: TSB)**




The long line assembly was intact from the broken steel cable to the small-diameter ropes. However, the ropes and electrical cables that were connected to the 2 survey loops had failed, and investigators were unable to determine whether they had failed during the occurrence or the recovery.

### 1.12.8 Emergency floats

During the Kitsault project, the helicopter operated over the ocean and was consequently fitted with DART Aerospace ULC emergency floats on 30 August 2022, in accordance with Supplemental Type Certificate SH97-69.[10]

The emergency float system consists of 3 floats located on each skid tube and plumbed to 1 compressed air cylinder for each side of the helicopter. The valves on the cylinders are cable-actuated by a lever mounted on the cyclic.

During normal operation, a float cover retains each float using snaps and Velcro. In the event of a helicopter ditching in the water, the pilot actuates the lever, which releases the compressed gas and rapidly inflates the floats out of the covers to provide flotation.

---

10 Transport Canada, Supplemental Type Certificate No. SH97-69: Installation of Emergency Floats System 20326-100 in accordance with FAA STC SR00470LA (issued 26 April 2000).

During the impact sequence, all of the floats had been released from the float covers and the left floats had partially inflated. The left actuating cable was likely activated momentarily by the impact forces during the sequence and released some of the compressed air into the left floats.

## 1.13 Medical and pathological information

### 1.13.1 Medical fitness for flight

At approximately 2030 on 07 November 2022, the pilot began shivering uncontrollably and went to bed. During the early morning hours of 08 November, the pilot awoke with the same symptoms and recorded a temperature of 38.9 °C. The pilot was observed to have difficulty holding his cellular phone. With no medical services or cellular coverage in the area, the pilot called 911 over Wi-Fi to consult with the British Columbia Ambulance Service for an assessment and, if necessary, an evacuation. During the 1st call, the pilot provided details of his location and his symptoms to the 911 dispatch operator. The operator informed the pilot that a paramedic specialist would call him back shortly for an assessment. The paramedic attempted to call the pilot back, but given that there was no cellular coverage, the paramedic was unable to connect with the pilot. The pilot called the 911 dispatch operator a 2nd and 3rd time, but for unknown reasons, the call dropped both times when the 911 operator tried transferring the pilot to the paramedic specialist. Before the 3rd call disconnected, the pilot reported that his symptoms had improved significantly. There is no record that the pilot attempted a 4th call nor that he pursued an evacuation.

Because of adverse weather conditions on 08 November, there was no flying planned for that day, so the pilot rested. He contacted the company's director of operations to report the events of that morning and the previous night and stated that he was going to monitor himself into the following day. The pilot opted to stay in Kitsault, in the meantime, and his temperature began to decrease to 38 °C.

On 09 November, the day of the occurrence, the pilot self-dispatched based on the favourable weather conditions and his perceived improvement in his symptoms.

### 1.13.2 Benign paroxysmal positional vertigo

Benign paroxysmal positional vertigo (BPPV) is a condition in the inner ear that, according to the *Canadian Medical Association Journal*, results in "[…] sudden, severe attacks of either horizontal or vertical vertigo, or a combination of both, precipitated by certain head positions and movements."[11] The journal goes on to describe the symptoms of BPPV as "[…] [a combination] of light-headedness, nausea, imbalance and, in severe cases, sensitivity to all directions of head movement."[12]

---

11 L. S. Parnes, S. K. Agrawal, J. Atlas, "Diagnosis and management of benign paroxysmal positional vertigo (BPPV)," *Canadian Medical Association Journal,* Vol. 169, Issue No. 7 (30 September 2003), p. 685.

12 Ibid.

A BPPV attack typically lasts less than 30 seconds, but its intensity as well as its after-effects of nausea and disequilibrium can prolong the whole experience for several minutes.[13] BPPV is a common disorder, and although it is normally not a serious condition, it can lead to dangerous situations, such as falls or other injuries or accidents.

Approximately 8 years before the occurrence, the pilot had a sudden onset of dizziness and was transported by ambulance to a hospital emergency department. The pilot was diagnosed with vertigo by the attending physician. Records indicate the pilot experienced 2 more vertigo events: one in November 2019 while off duty and one in October 2020 while on assignment in the Yukon. In both cases, the pilot received a medical examination from multiple physicians and was diagnosed with BPPV. None of the dizziness episodes reported by the pilot took place while he was in flight.

The most recent examination conducted by a TC Civil Aviation Medical Examiner (CAME) was in June 2022, and the recommendation was to renew the pilot's Category 1 medical certificate. At the time of this examination, this CAME, who had conducted 9 of the last 10 periodic examinations of the pilot since 2017, was not, and had never been, informed of any of the pilot's previous events of dizziness and diagnoses of vertigo. In addition, TC's Medical Examination Report (MER) 26-0010, which must be completed by the CAME, asks whether the applicant has ever had or been treated for dizziness; the response to this question found in all MERs since 2017 was "No."

From the initial diagnosis of vertigo up until the occurrence, the pilot was prescribed betahistine by multiple physicians to treat the condition. The prescription information was provided to the CAME on the list of the pilot's prescriptions between November 2019 and November 2020. Although betahistine is known as a medication for vertigo, the CAME associated those prescriptions with the pilot's known condition of chronic tinnitus and hearing loss at high frequencies. Betahistine is used as an off-label drug for these hearing conditions.

There was no indication that either of the 2 most recent CAMEs who had administered the pilot's medical examinations requested information related to vertigo. Betahistine was not on the list of medications for the June 2022 MER.

### 1.13.3 Transport Canada aviation medical certification

The primary activity of TC's Civil Aviation Medicine Branch is performing medical assessments required for the certification of licensed aviation personnel. As stated in *Canadian Aviation Regulations* (CARs) Standard 424.04(1)(b),

> […] Medical Certificates are issued by the Minister of Transport through the office of the Regional Director, Aviation Licensing following receipt of:
>
> (i) a medical examination report, provided the candidate meets the pertinent medical standards and has been assessed medically fit or fit subject to any

13 Ibid.

> restriction or limitation recommended by Civil Aviation Medicine Division Medical Staff; […][14]

#### 1.13.3.1 Medical examination

The purpose of the medical examination is to determine whether an applicant meets the standards for the issuance of a medical certificate, which is needed to validate a pilot's licence. TC is mainly concerned with managing the risks to aviation, such as incapacitation, for the period of the licence. If necessary, further medical examination may be requested.

In accordance with CARs Standard 424.04(2)(a), "[e]very applicant for a medical certificate or revalidation thereof shall undergo a medical examination by a CAME."[15] CARs Standard 424.17(3) requires that the CAME examine the pilot carefully and that the examination be "sufficiently thorough so as to determine whether the applicant meets the requirements in respect of the category of medical certificate that is applied for or in respect of which a validation is sought."[16]

TC's *Handbook for Civil Aviation Medical Examiners*[17] provides guidance to CAMEs on how to perform medical examinations and assess medical fitness. During a medical examination, CAMEs are required to complete an MER. The original report should be sent to the appropriate regional office for the Regional Aviation Medical Officer to review, if required.

Holders of a commercial pilot licence (aeroplane or helicopter) require a valid Category 1 medical certificate. Commercial pilots must renew their medical certificate, and therefore attend a TC medical examination, every 12 months. However, pilots who are 40 years of age or older and conducting single-pilot operations with passengers on board, or who are 60 years of age or older, must renew their medical certificate every 6 months.[18]

The occurrence pilot, who was over 65 years of age, regularly attended a TC medical examination every 6 months, except for July 2020, when he was eligible for the attestation of medical fitness due to the COVID-19 pandemic.[19] The pilot held a Category 1 medical certificate that was valid until 01 January 2023.

---

14 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Standard 424: Medical Requirements, paragraph 424.04(1)(b).

15 Ibid., paragraph 424.04(2)(a).

16 Ibid., paragraph 424.17(3).

17 Transport Canada, TP 13312, *Handbook for Civil Aviation Medical Examiners*, at tc.canada.ca/en/aviation/publications/handbook-civil-aviation-medical-examiners-tp-13312 (last accessed on 15 July 2024).

18 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, subsection 404.04(6.2).

19 Transport Canada, Exemption NCR-062-2020: Exemption from paragraphs 404.03(2)(a) and (b) and 404.04(1)(b) of the *Canadian Aviation Regulations* (03 June 2020).

#### 1.13.3.2 Reporting responsibilities of physicians

The *Aeronautics Act* states,

> [w]here a physician […] believes on reasonable grounds that a patient is a flight crew member […] or other holder of a Canadian aviation document that imposes standards of medical […] fitness, the physician […] shall, if in his opinion the patient has a medical […] condition that is likely to constitute a hazard to aviation safety, inform a medical adviser designated by the Minister forthwith of that opinion and the reasons therefor.[20]

As part of provincial licensing, physicians are informed about their provincial and federal mandatory reporting responsibilities. Physicians can access this information through a web-based document published by the Canadian Medical Association (CMA) titled *CMA Driver's Guide: Determining medical fitness to operate motor vehicles*,[21] which contains a section on Aviation. This section provides details of the *Aeronautics Act*'s reporting requirements and informs physicians that they must inform the pilot and the Regional Aviation Medical Officer of any medical condition that might affect flight safety. Common conditions that require mandatory reporting by the physician are listed, including "any condition that interferes even temporarily with balance or coordination."[22] The contact details for the Civil Aviation Medicine headquarters and the web address for the Civil Aviation Medicine regional offices are also provided.

To assist the physicians in identifying aviation personnel, the *Aeronautics Act* states,

> [t]he holder of a Canadian aviation document that imposes standards of medical […] fitness shall, prior to any medical […] examination of his person by a physician […], advise the physician […] that he is the holder of such a document.[23]

The occurrence pilot's profession was noted throughout his medical file while he was being treated by multiple physicians for symptoms of dizziness.

When the pilot was diagnosed with BPPV in November 2019, the attending physician informed the pilot that he could not be granted permission to fly and instructed the pilot to follow up with his family doctor and the CAME. During his episode in October 2020, the pilot removed himself from duty and notified his employer that he was unfit to fly. After consulting his family physician and a secondary physician, the pilot was administered additional tests and treatment and told to modify his duties until his symptoms subsided. There was no indication in either the TC medical records or the pilot's medical records that the attending physicians had informed TC of the condition.

The investigation determined that some of the attending physicians were not aware of their aviation-related reporting responsibilities.

---

20 Government of Canada, *Aeronautics Act* (R.S.C., 1985, c. A-2), subsection 6.5(1).

21 Joule Inc., *CMA Driver's Guide: Determining medical fitness to operate motor vehicles*, 9.1 edition (2019).

22 Ibid., Section 26.11: Nervous system, p. 126.

23 Government of Canada, *Aeronautics Act*, R.S.C., 1985, c. A-2, subsection 6.5(2).

#### 1.13.3.2.1 Safety Advisory Letter

On 09 October 2021, a privately registered Cavalier SA102.5 aircraft collided with terrain. The pilot was fatally injured and the passenger received serious injuries. As part of that investigation,[24] in which it was determined that the pilot's family physician had not informed TC about medication prescribed to treat an acute medical condition, the TSB issued Air Transportation Safety Advisory Letter A21W0089-D2-A1 on 11 January 2023. The letter informed TC that not all physicians were aware of the requirement to report medical issues for their patients that hold a pilot licence. It also encouraged TC to work with the CMA to develop communication strategies to increase the awareness of the reporting requirements for physicians under the *Aeronautics Act.*

On 19 January 2023, TC responded to this Safety Advisory Letter. In its response, TC stated that TC Civil Aviation Medicine had coordinated with the CMA to increase awareness of the reporting requirements for physicians. In addition, TC Civil Aviation subsequently updated the aviation section in the latest edition of the CMA's guide, which was released in 2023, stating that

> [g]iven the high distribution of the CMA Driver's Guide, TC believes this will be a high-impact and influential means of communicating the mandatory reporting obligation to Canadian physicians.[25]

It could not be determined how often family physicians are informed of their provincial and federal reporting responsibilities, or how often they access or read the *CMA Driver's Guide: Determining medical fitness to operate motor vehicles*.

Since 2000, there have been 9 accidents, including this one, in which a finding as to risk was made regarding pilots who had medical conditions that affected safety but were not reported to TC. These accidents resulted in 11 fatalities and 7 serious injuries.[26]

### 1.13.3.3 Disclosure responsibilities of pilot applicants

Because CAMEs are often not the applicant's family physician, they must rely to a large extent on information disclosed by the applicant. TC recognizes that aviation personnel may not volunteer information that could affect their medical certification, typically because they fear losing their medical certificate and, in some cases, their employment.

The *Handbook for Civil Aviation Medical Examiners* and CARs Standard 424 require the applicant for a medical certificate to provide complete and accurate information regarding their health. Although these requirements refer to disclosure during the medical examination, by signing the declaration, applicants are also committing to disclosure for the duration of the medical certification period. However, the applicant is not required by TC to

---

24 TSB Air Transportation Safety Investigation Report A21W0089.

25 Transport Canada, Transport Canada Response to Aviation Safety Advisory Letter A21W0089-D2-A1 (19 January 2023).

26 TSB air transportation safety investigation reports A21W0090, A21W0089, A19P0142, A14O0077, A14A0067, A10A0041, A07P0357, and A03P0265.

provide the results of personal medical tests, such as laboratory test results, unless these results are required as part of the civil aviation medical certification process.

In this occurrence, there was no indication in the TC medical records that the pilot reported his history of dizziness and BPPV diagnosis to the attending CAME.

### 1.13.4 Coroner's report

The British Columbia Coroners Service reported that there was no anatomical evidence to suggest a medical event that could have precipitated the crash. The report also noted that there was an increased risk of an incident if the pilot was feeling unwell before the occurrence.

The toxicology report did not indicate any significant findings.

## 1.14 Fire

There was no indication of fire either before or after the occurrence.

## 1.15 Survival aspects

The pilot was wearing a flight helmet and a 4-point safety belt, which consisted of a lap belt and a dual shoulder harness that was retained by a single inertia reel. However, the accident was not survivable due to the impact forces involved.

The helicopter was equipped with a Kannad AF-H Integra 406 MHz emergency locator transmitter (ELT). The ELT remained attached to the fuselage and functioned as designed. As a result, the Joint Rescue Coordination Centre (JRCC) was immediately notified of the occurrence and dispatched 2 search and rescue aircraft to the site. The ELT then assisted these 2 aircraft in locating the occurrence helicopter despite it being obscured on a heavily forested mountainside.

## 1.16 Tests and research

### 1.16.1 TSB laboratory reports

The TSB completed the following laboratory reports in support of this investigation:

- LP126/2022 – NVM Data Recovery – Various
- LP130/2022 – Annunciator Panel Analysis

## 1.17 Organizational and management information

Geotech Aviation Ltd. is the sister company of Geotech Ltd. and specializes in airborne geophysical survey mapping. The privately owned helicopter company is located in Holland Landing, Ontario, and holds an operator certificate for commercial visual flight rules aerial work and air taxi services in accordance with CARs subparts 702 and 703, respectively. At the time of the occurrence, the company fleet consisted of 9 Airbus Helicopters AS350 B3 aircraft.

The company uses a Type D operational control system[27] for dispatch and a web-based flight-tracking system to provide the location of all helicopters to company personnel.

The company is also a TC–approved maintenance organization for all non-specialized work on the aircraft types it operates.

## 1.18 Additional information

### 1.18.1 Airborne geophysical survey

In airborne geophysical survey mapping with the Versatile Time Domain Electromagnetic (VTEM) system, subterranean data is collected from the external loops (which are suspended below the helicopter) and recorded on a computer processor secured behind the pilot seat of the helicopter.

Use of the VTEM loops is limited to favourable weather conditions, consisting of light and stable winds, good visibility, and high ceilings. Owing to inclement seasonal weather patterns, the project in Kitsault was limited to 7 days of flying, 5 of which were dedicated to airborne surveying in the 30 days before the occurrence. The loops must be stable in flight at slower airspeeds and close to the ground to produce usable data. In addition, the survey equipment must be flown up to approximately 3000 feet AGL for periodic calibration and data storage.

Geotech's helicopters are equipped with radar altimeters (RADALTs) that pilots use to determine their height above ground. However, in mountainous and undulating terrain, RADALTs are not accurate, so pilots rely on visual cues to prevent the survey equipment from contacting the ground. In treed areas, the trees increase the minimum height above ground at which the equipment can be flown, and pilots must judge the treetop heights to prevent a collision of the equipment with the trees and yet be low enough to collect usable survey data.

Geotech permits a geophysical equipment operator to be on board the helicopter during survey flights. When on board, the equipment operator assists the pilot with operating the survey equipment, determining the flight path, and watching for in-flight obstacles. When conducting survey flights over mountainous terrain, it was common practice for pilots to fly solo, which would allow for an increase in fuel load, a longer flight time, and better aircraft performance. There is no company standard for determining when an equipment operator accompanies the pilot during the survey flights, and the decision is left to the crew on site.

Between July 2016 and December 2022, the company recorded 20 incidents during survey flights that involved the survey equipment contacting treetops and terrain. In these cases, there were no reported injuries, and any damage was limited to the survey equipment.

---

[27] A Type D operational control system delegates operational control from the operations manager to the pilot-in-command. Flights operated under this system are self-dispatched and released by the pilot-in-command.

# 2.0 ANALYSIS

The investigation determined that weather, aircraft performance, and pilot proficiency were not factors in this occurrence. The flight data available to the investigation was limited to 1-minute reporting intervals and did not include audio, video, or cockpit data. As a result, the investigation could not establish a detailed sequence of events in the cockpit before or during the occurrence.

The analysis will discuss indications from the aircraft wreckage as well as the pilot's medical fitness. The analysis will also discuss the approach taken by Transport Canada (TC) for managing pilot medical assessments, as well as the importance of on-board flight recorders.

## 2.1 Occurrence flight

### 2.1.1 Aircraft wreckage

The break-up of the occurrence helicopter's main rotor head and the significant damage to the main rotor blades during the impact sequence were consistent with a main rotor impacting trees while under engine power. In addition, the engine was determined to be operating normally based on a visual examination and the absence of faults in the digital engine control unit.

Investigators conducted multiple tests on the cargo hook release system both while it was attached to the wreckage and after it had been removed. Although the tests indicated that the release system at the hook was operating normally, the broken weak link cable at the occurrence site indicated that the Versatile Time Domain Electromagnetic external loops were likely attached to the cargo hook at the time of the occurrence. The pilot had not activated the hook's mechanical or electrical release system.

Based on the fact that 1 main rotor blade was found in a damaged tree 48 feet above the ground, the external survey loops, suspended 140 feet below the helicopter's cargo hook, were already resting in the tree canopy during the tree strike. During the crash sequence, the aircraft likely descended rapidly after the tree strike and, with the survey loops anchored in the trees, the fuselage entered a roll until the weak link broke. The aircraft then collided with additional trees, causing a sudden deceleration that resulted in the ejection of the engine and main gearbox along with the separation of the tail boom. The fuselage came to rest inverted and pointing downhill.

### 2.1.2 Medical fitness for duty

Geotech Aviation Ltd. has a Type D operational control system in which the pilot-in-command is responsible for operational control and aircraft dispatch. The pilot's decision to undertake the occurrence flight was likely influenced by the improvement in his symptoms from the previous day and the favourable weather conditions.

In the pilot's final communication with the geophysical equipment operator, the pilot indicated that he was experiencing uncontrollable shivering, similar to what he had

experienced approximately 38 hours earlier, on the evening of 07 November. Although the severity of the pilot's illness at the time of the communication is unknown, the pilot opted to return to the staging area and, during the course of that return flight, pressed the emergency button on the aircraft flight-tracking system, indicating distress. The pilot continued to fly the helicopter for approximately 16 minutes more, during which the flight path became erratic with fluctuating airspeeds up to the point of impact with terrain.

The pilot had extensive flight experience on the occurrence helicopter in mountainous terrain and with the survey loops attached. However, although the pilot activated the emergency button several minutes before the occurrence, there was no communication from the pilot to the equipment operator indicating that an aircraft or equipment malfunction had occurred. In addition, the suspended survey loops, which added to the helicopter's weight and drag, were not detached using either of the 2 available and operational cargo hook release systems.

The coroner's examination did not identify any anatomical evidence to suggest that a medical event could have precipitated the crash, or any cause of the uncontrollable shivering that the pilot had experienced in the days leading up to the occurrence. However, the pilot likely experienced a degree of incapacitation on the return flight based on his final radio communication (in which he reported feeling unwell), the absence of an aircraft or equipment failure, the unusual flight path on the inbound leg back to the staging area, and the retention of the survey loops up until the point of impact.

Finding as to causes and contributing factors

During the occurrence flight, the pilot experienced a medical event likely causing a degree of incapacitation that resulted in an erratic flight path, and the helicopter impacted terrain.

## 2.2 Transport Canada medical assessment

The pilot reported symptoms of shivering on the day of the occurrence flight and in the days leading up to it. These symptoms are not consistent with the typical symptoms of vertigo, which are dizziness, nausea, sensitivity to head movement, and a disturbance of balance. Although the pilot had experienced vertigo in the past, his last recorded vertigo event was in October 2020. As a result, the investigation could not determine whether the pilot had experienced vertigo in the occurrence.

Nevertheless, vestibular disorders, such as vertigo, are considered a risk to flight safety, as described in the *CMA Driver's Guide: Determining medical fitness to operate motor vehicles*. As a result, physicians must report these disorders to the Regional Aviation Medical Officer in accordance with the *Aeronautics Act*. Furthermore, an applicant for a medical certificate endorses a legal declaration to provide their complete and accurate health information to the Civil Aviation Medical Examiner (CAME) at the time of assessment.

Although the occurrence pilot's profession was noted on his medical file while he was being treated by multiple physicians for symptoms of dizziness, his episodes of dizziness and diagnoses of benign paroxysmal positional vertigo were not disclosed to the CAME by either

the pilot or his attending physicians. As a result, the CAME was unable to adequately assess the pilot for medical fitness.

The *CMA Driver's Guide: Determining medical fitness to operate motor vehicles* was revised in 2023 by TC Civil Aviation Medicine to include an update to the guide's aviation section and, specifically, a reminder to physicians of their reporting responsibilities. However, it is unclear whether physicians regularly review this resource for information on aviation medical reporting or whether TC Civil Aviation Medicine will continue to raise awareness of the reporting requirements for physicians.

Findings as to risk

If CAMEs are not informed by physicians and pilots about medical conditions and/or medications that could affect the safe operation of an aircraft, there is an increased risk that pilots will be certified without appropriate safety mitigations in place.

If physicians are not regularly informed and updated on their federal responsibilities to report medical conditions and/or medications that may affect flight safety, TC may not have the information required to accurately determine a pilot's medical fitness for flight.

## 2.3 Flight data recorders

The occurrence aircraft was equipped with a Guardian Mobility Flightcell DZMx satellite and cellular tracking unit. The investigation relied on the satellite data to reconstruct the flight path, but the tracker reporting intervals, though reduced from 2 minutes to 1 minute, were still too sparse for a detailed flight analysis, and the helicopter's exact manoeuvring during the final moments of the flight could not be determined. In addition, the device does not record helicopter performance data, cockpit audio, or cockpit imagery.

Lightweight data recorder technology is available for installation in smaller airplanes and helicopters. These systems can be used during an accident investigation to determine what the aircraft was doing and which pilot actions were taken in the minutes leading up to the occurrence. Recorders increase the opportunity to fully understand why an accident occurred and to identify safety deficiencies that may be significant.

TC has agreed in principle with TSB Recommendation A18-01 and continues to work with the aviation industry to address the mandatory installation of lightweight data recorders. However, no regulatory requirements have been issued to date.

In the absence of any flight data recorder, this investigation was unable to determine the full context of the collision with terrain.

Finding as to risk

If cockpit and flight data recordings are not available to an investigation, there is a risk that safety deficiencies will not be identified to advance transportation safety.

# 3.0 FINDINGS

## 3.1 Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. During the occurrence flight, the pilot experienced a medical event likely causing a degree of incapacitation that resulted in an erratic flight path, and the helicopter impacted terrain.

## 3.2 Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

1. If Civil Aviation Medical Examiners are not informed by physicians and pilots about medical conditions and/or medications that could affect the safe operation of an aircraft, there is an increased risk that pilots will be certified without appropriate safety mitigations in place.

2. If physicians are not regularly informed and updated on their federal responsibilities to report medical conditions and/or medications that may affect flight safety, Transport Canada may not have the information required to accurately determine a pilot's medical fitness for flight.

3. If cockpit and flight data recordings are not available to an investigation, there is a risk that safety deficiencies will not be identified to advance transportation safety.

# 4.0 SAFETY ACTION

## 4.1 Safety action taken

The Board is not aware of any safety action taken following this occurrence.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 14 August 2024. It was officially released on 25 September 2024.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.