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

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A23Q0038

CONTROLLED FLIGHT INTO TERRAIN

Canadian Helicopters Limited – Hélicoptères Canadiens Limitée
Bell 206L (helicopter), C-GLQY
Vallillee Lake, Quebec
07 April 2023

Canada

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Table of contents

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Summary

On 07 April 2023, at 0821 Eastern Daylight Time, the Bell 206L helicopter (registration C-GLQY, serial number 45146) operated by Canadian Helicopters Limited – Hélicoptères Canadiens Limitée took off from ArcelorMittal's facilities in Port-Cartier, Quebec, with the pilot and 3 passengers on board. The pilot was conducting a northbound visual flight rules flight to the company's Fox camp located along the railway, 49 nautical miles northwest of Port-Cartier.

Snow showers began in the vicinity of Vallillee Lake, Quebec, approximately 38 nautical miles northwest of Port-Cartier, which decreased the visibility and lowered the cloud ceiling. The visibility deteriorated very quickly; the pilot therefore reduced his speed and height. While he was flying over a small lake connected to the northern part of Vallillee Lake, the pilot suddenly lost the visual references in front of him. He made a right turn, where he could see trees on the east shore. During the turn, he momentarily lost his visual references, but regained them just before the helicopter struck the lake's frozen surface. The helicopter rolled onto its left side and was substantially damaged. The pilot activated the emergency locator transmitter. The 4 occupants were able to extricate themselves from the wreckage. Shortly afterwards, another company helicopter rescued them and transported them to the hospital in Sept-Îles, Quebec.

1.0 FACTUAL INFORMATION

1.1 History of the flight

On 07 April 2023, the pilot of a Bell 206L helicopter operated by Canadian Helicopters Limited – Hélicoptères Canadiens Limitée (CHL) began his day around 0700.[1] He was planning on transporting 4 workers to ArcelorMittal's Fox, Love, and Fire Lake camps located along the railway connecting Port-Cartier, Quebec, to the Fire Lake mine, Quebec. However, to remain within the helicopter's maximum take-off weight, only 3 passengers could board with their luggage. The pilot consulted weather forecasts for the flight route that indicated that the weather was suitable for a visual flight rules (VFR) flight.

The helicopter took off at 0821 from ArcelorMittal's facilities in Port-Cartier and flew northbound along the railway. At approximately 0839, between the Charles and Dog rail bypasses, the ceiling lowered and visibility decreased, which settled at less than 3 statute miles (SM) due to light snow showers. At 0851, while the helicopter was flying over the Dog rail bypass at approximately 700 feet above ground level (AGL), near Vallillee Lake, Quebec, the ceiling continued to lower ahead, and the pilot descended to remain clear of the clouds.

Approximately 2 minutes later, under the lower ceiling, the helicopter was in an area of snow showers that reduced the visibility to between 1 SM and ¾ SM, approximately. The pilot immediately slowed down and began a descent to below 500 feet while remaining on the east side of the railway, where the terrain was the lowest. This flight route was well known to the pilot and a localized weather phenomenon that reduced the visibility and lowered the ceiling had been observed in the area several times in the past. Believing that he was experiencing this same phenomenon, the pilot headed to where the ceiling and visibility typically improved.

At 0854, while the helicopter was flying over the southern shore of the small lake connected to the northern part of Vallillee Lake, at a ground speed of 42 mph and a height of 210 feet AGL, the entire contour of the lake, and a bit beyond, was visible. Confident that conditions would soon be improving, the pilot continued the flight to cross over the small lake.

Approximately 5 seconds later, forward visual references were suddenly lost. Given that a left turn was not an option because the ground rose along the left shore, the pilot immediately began turning right and could see trees along the shore. While in the turn, the pilot lost sight of the trees that were serving as his visual references, but then he saw other trees further to the right. As he continued turning toward the trees, the pilot believed that he was maintaining a height of approximately 300 feet and could escape from these poor weather conditions by turning around, when the helicopter suddenly struck the lake's frozen surface and rolled onto its left side. The pilot activated the emergency locator transmitter.

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[1] All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

Three of the occupants were able to extricate themselves from the wreckage despite their pain. The 4th occupant needed assistance from the others due to severe back pain. The pilot used the portable frequency modulation radio to call for help. The survival equipment on board was retrieved, and the occupants began walking toward the eastern shore, where a camp was located. The intensity of the snow showers prevented them from seeing the shore and the camp, but the showers ceased a few minutes later and the sky became partially clear.

The occupants decided to pitch the survival tent on the lake's southeast shore, because the water at the mouth of the creek, between them and the camp, was not frozen.

A company helicopter was dispatched to the site and landed around 1000. The occupants were transported to the hospital in Sept-Îles, Quebec.

1.2 Injuries to persons

The pilot and 3 passengers were 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	0	0	–	0
Serious	0	0	–	0
Minor	1	3	–	4
Total injured	1	3	–	4

1.3 Damage to aircraft

The helicopter was substantially damaged as a result of impact forces and there was no fire.

1.4 Other damage

There was no other damage.

1.5 Personnel information

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

Table 2. Personnel information

Pilot licence	Commercial pilot licence (CPL) - helicopter
Medical expiry date	01 September 2023
Total flying hours	3536.1
Flight hours on type	1580.2
Flight hours in the 24 hours before the occurrence	0.6

Flight hours in the 7 days before the occurrence	9.5
Flight hours in the 30 days before the occurrence	35.7
Flight hours in the 90 days before the occurrence	97.2
Flight hours on type in the 90 days before the occurrence	97.2
Hours on duty before the occurrence	3
Hours off duty before the work period	15

The pilot had been working for CHL since 2019.

He had received flight training on Bell 206 and AS350 helicopters in March 2022. His pilot proficiency check was valid until 01 June 2023.

For approximately 4 years, the pilot had been assigned to transporting ArcelorMittal workers between Port-Cartier and the Fire Lake mine. Based on a review of the pilot's work and rest schedules, there was no indication that the pilot's performance was degraded by fatigue during the occurrence flight.

1.6 Aircraft information

Table 3. Aircraft information

Manufacturer	Bell Helicopter Textron
Type, model, and registration	Bell 206L, C-GLQY
Year of manufacture	1977
Serial number	45146
Certificate of airworthiness issue date	24 February 1978
Total airframe time	28 909.7 hours
Engine type (number of engines)	Allison 250-C20R/2 (1)
Rotor type (number of rotor blades)	Semi-rigid rotor (2)
Maximum allowable take-off weight	4000 lb (1814 kg)
Recommended fuel type(s)	Jet A, A-1, B
Fuel type used	Jet A-1

The aircraft was maintained in accordance with a maintenance schedule approved by Transport Canada (TC). The weight and centre of gravity were within the prescribed limits.

There were no outstanding defects recorded in the technical records or reported by the pilot at the time of the occurrence. In addition, there was no indication that a component or system malfunction played a role in this occurrence. The helicopter was certified and equipped for daytime VFR flights. Furthermore, it was equipped with an attitude indicator and a vertical speed indicator.

1.7 Meteorological information

The following meteorological information was taken from a weather analysis report[2] prepared for the TSB by Environment and Climate Change Canada for the purposes of this investigation.

1.7.1 Weather forecast for Sept-Îles area

At 0900 on 07 April 2023, the North Shore was experiencing an unstable cold air mass behind a frontal wave over Newfoundland whose upper level trough was over Labrador. Weather conditions in the Sept-Îles area were generally VFR flight conditions, with visibility greater than 6 SM and ceilings above 2500 feet.

A band of clouds over a surface trough northwest of Sept-Îles was moving eastward. This trough was characteristic of a convective process, and convective clouds had developed along the trough shortly before 0800.

The aerodrome routine meteorological report (METAR) issued at 0900 on 07 April for Sept-Îles Airport (CYZV) indicated the following conditions:

- winds from 280° true at 8 knots;
- visibility of 30 SM;
- few clouds at 3000 feet AGL, a broken ceiling at 7000 feet AGL, and another broken cloud layer at 11 000 feet AGL;
- temperature 0 °C, dew point −4 °C;
- altimeter setting 29.70 inches of mercury.

The Clouds and Weather Chart from the graphic area forecast (GFA) issued at 0733 on 07 April for the Atlantic region was valid from 0800 to 2000 and forecast the following weather conditions for the Sept-Îles area (Appendix A):

- broken cloud layers from 3000 to 10 000 feet above sea level (ASL);
- visibility greater than 6 SM;
- patchy clouds with ceilings at 1200 feet AGL;
- wind gusts of 25 knots.

Within the same cloud mass, but much further north than the planned flight route, isolated towering cumulus (TCU) clouds were expected, with light snow showers and a visibility of 2 SM.

On the south shore of the St. Lawrence River, a surface trough producing occasional TCUs with snow and rain showers was forecast, as well as a visibility of 2 SM.

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2 Environment and Climate Change Canada, *Analyse météorologique – 07 avril 2023 - Sept-Îles, Québec* (29 June 2023).

1.7.2 Weather conditions at the occurrence site

When the surface trough arrived near the site of the accident at around 0800, convection in the area was at its peak and the convective clouds were topped at 14 000 feet.

Convective clouds like this are conducive to the production of brief, but very heavy snow showers. While the surface trough was passing through, conditions could deteriorate quickly, with heavy snow showers significantly reducing horizontal and vertical visibility.

The maximum snowfall rate was 3 to 4 cm/h, suggesting that the cloud ceilings lowered and that the visibility decreased down to ¼ SM due to the snow showers. There was every indication that a snow squall occurred along the surface trough. Gusts up to 35 knots, associated with convective clouds, could have produced moderate to severe turbulence for brief periods.

When the occupants were being transported to the Sept-Îles Hospital, heavy, isolated snow showers were observed along the flight route. Approximately 2 hours earlier, no snow showers were observed along the initial northbound path. An overcast cloud layer hid the convective clouds, preventing the pilot from identifying the mature convective cells while in flight. These cells would have been a sign of the imminent onset of snow showers.

1.7.3 Instrument and visual meteorological conditions

Instrument meteorological conditions (IMC) and visual meteorological conditions (VMC) are defined as:

- IMC: "Meteorological conditions less than the minima specified in Subpart 602 of the *Canadian Aviation Regulations* (CARs) for visual meteorological conditions (VMC), expressed in terms of visibility and distance from cloud."[3]
- VMC: "Meteorological conditions, expressed in terms of visibility and distance from cloud, equal to or greater than the minima specified in CAR 602."[4]

These minima are shown in Figure 1 below. The CARs stipulate that an aircraft must be operated with visual reference to the surface.[5] In general, VFR flights are not to be conducted in IMC.[6]

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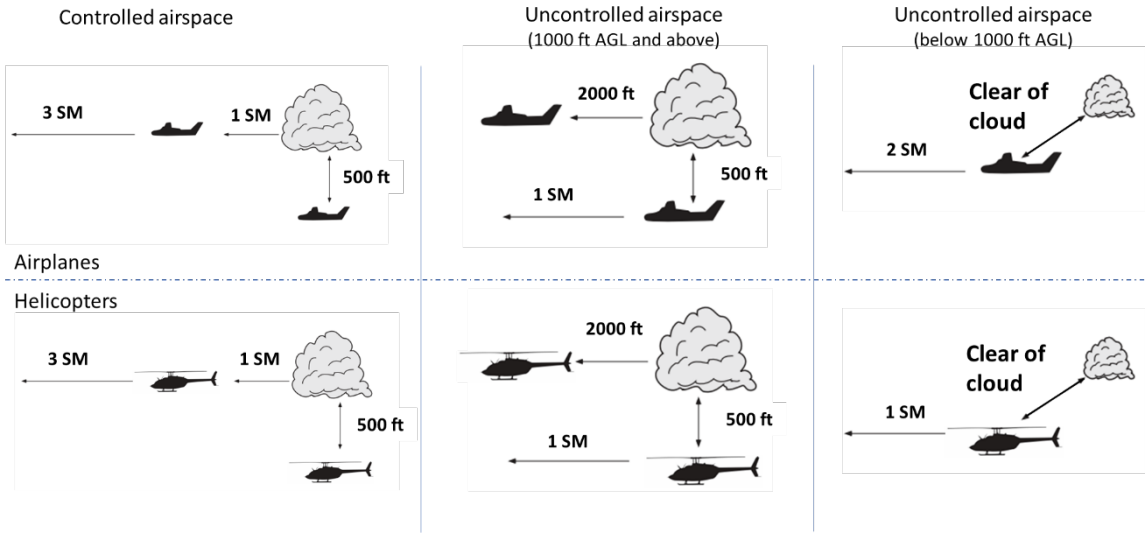
3 Transport Canada, TP 14371E, *Transport Canada Aeronautical Information Manual* (TC AIM), GEN – General (23 March 2023), Section 5.1 Glossary of Aeronautical Terms, p. 32.

4 Ibid., p. 38.

5 Transport Canada, SOR/96–433, *Canadian Aviation Regulations*, sections 602.114 and 602.115.

6 Ibid., section 602.121.

Figure 1. Minimum visual meteorological conditions for airplanes and helicopters in controlled and uncontrolled airspace (Source: TSB)



1.8 Aids to navigation

Not applicable.

1.9 Communications

Not applicable.

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, it was equipped with a satellite flight-tracking system which recorded, among others, the following parameters every 5 seconds: GPS (global positioning system) position, altitude ASL, date, time, ground speed, and direction of flight.

According to information gathered during the investigation, the cloud ceiling lowered considerably after the Dog rail bypass and sudden snow showers quickly decreased visibility to approximately ¾ SM in the northern part of Vallillee Lake.

Furthermore, the helicopter's height continued to decrease after the Dog rail bypass, and its speed was suddenly reduced when the helicopter reached the northern part of Vallillee Lake (Figure 2). Thirty seconds elapsed between the time when, according to estimates, visibility was suddenly reduced to approximately ¾ SM (Figure 2, point 1) and the last point recorded before the helicopter began to turn around (Figure 2, point 2).

Figure 2. Flight path of the occurrence helicopter, according to data from the satellite flight-tracking system (Source: Google Earth, with TSB annotations)

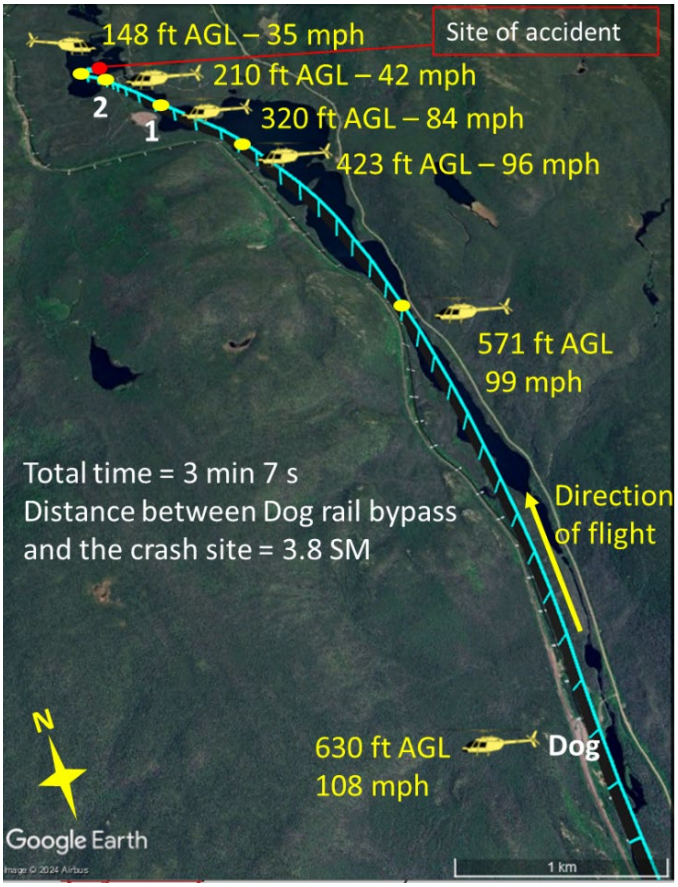
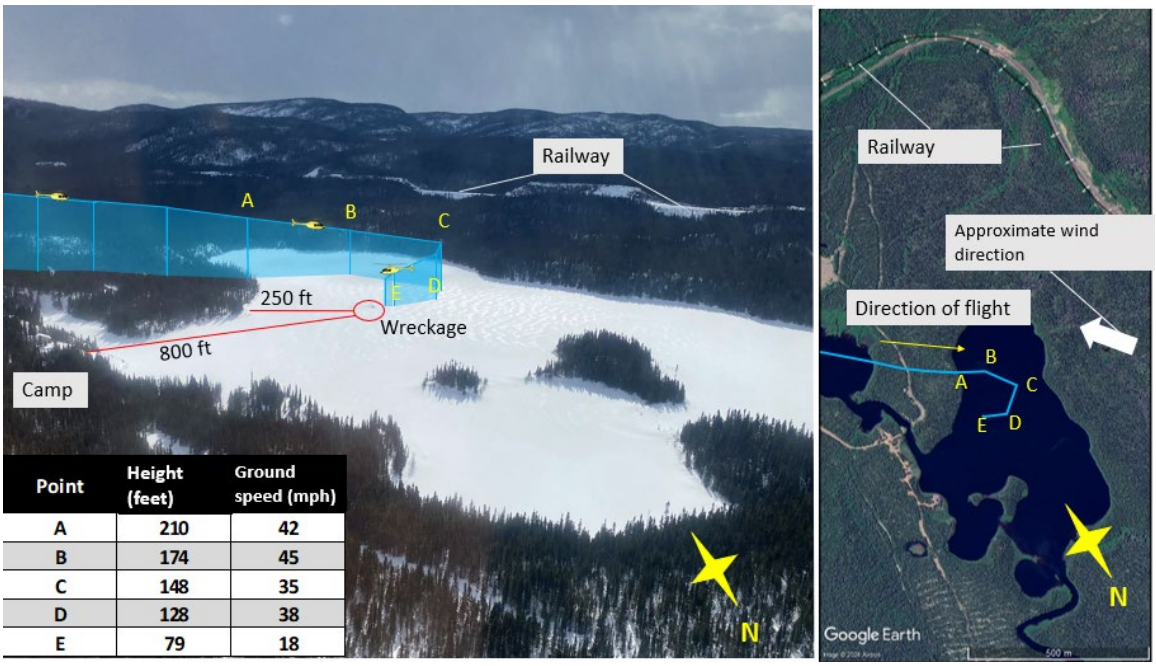


Figure 3 shows the helicopter's height and ground speed along the flight path as it was flying over the frozen lake. The investigation was unable to determine whether the descent was noticed by the pilot and intentional when he began crossing the lake. The pilot lost visual references between point A and point B (Figure 3), 5 seconds after he began crossing the lake (Figure 3, point A).

Figure 3. Aerial view of the scene of the accident and flight path of the occurrence helicopter, with indications of its height and speed according to the global positioning system (Sources: Canadian Helicopters Limited – Hélicoptères Canadiens Limitée [left image] and Google Earth [right image], with TSB annotations)



Point	Height (feet)	Ground speed (mph)
A	210	42
B	174	45
C	148	35
D	128	38
E	79	18

1.12 Wreckage and impact information

The helicopter was lying on its left side, with the nose pointing south-southeast (Figure 4). The integrity of the cockpit was not compromised. The main rotor head and 2 blades had separated from the mast and were lying in front of the wreckage. The tail fin and tail rotor were partially torn from the tail boom. The landing gear was deformed. The right aft cross tube had broken off at the attachment point and the left aft cross tube had staved in the belly of the helicopter.

Figure 4. Photo of the wreckage taken the day of the occurrence (Source: Canadian Helicopters Limited – Hélicoptères Canadiens Limitée)

1.13 Medical and pathological information

According to information gathered during the investigation, there was no indication that the pilot's performance was affected by medical or physiological factors.

1.14 Fire

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

1.15 Survival aspects

All occupants were wearing their full safety belts at the time of impact.[7] The survival kit and tent were easily retrieved during evacuation because they were attached to one of the rear seats.

1.16 Tests and research

1.16.1 TSB laboratory reports

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

- LP067/2023 – NVM Recovery – GPS and Flight Tracker

1.17 Organizational and management information

1.17.1 Canadian Helicopters Limited – Hélicoptères Canadiens Limitée

At the time of the occurrence, CHL was operating a fleet of 87 single- and multi-engine helicopters from 19 bases throughout Canada, pursuant to an air operator certificate (AOC) issued by TC for flight operations conducted under CARs subparts 702 (Aerial Work), 703 (Air Taxi Operations), and 704 (Commuter Operations) of the CARs. The occurrence flight was conducted under Subpart 703 of the CARs. CHL's head office is located in Les Cèdres, Quebec.

CHL's AOC includes a special authorization regarding minimum flight visibility for daytime VFR flights in uncontrolled airspace, for company helicopters conducting flight operations under subparts 702 and 703 of the CARs. This special authorization allows for visibility to be reduced to ½ SM subject to the following conditions:

- "[P]ilots shall have achieved at least 500 hours of pilot-in-command experience in helicopters."[8]
- "Helicopters shall be operated at a reduced air speed that will provide the pilot-in-command adequate opportunity to see and avoid obstacles."[9]
- The pilot shall receive the training described in the CARs standard.[10]

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7 The helicopter was equipped with safety belts, consisting of a lap strap and a 4-point shoulder harness, at each of the 7 seats on board.

8 Transport Canada, SOR/96–433, *Canadian Aviation Regulations*, Standard 722, paragraph 722.17(2)(a) and Standard 723 (Helicopters), paragraph 723.28(a).

9 Ibid., Standard 722, paragraph 722.17(2)(b) and Standard 723 (Helicopters), paragraph 723.28(b).

10 See paragraphs 722.17(2)(c) and 723.28(c) of CARs standards 722 and 723 (Helicopters) for a detailed description of the training.

- "The Company Operations Manual shall contain low visibility operational procedures and pilot decision making considerations for operation in visibility conditions of less than one mile […]."[11]

1.17.1.1 Operational requirements

Pursuant to section 723.105 of CARs Standard 723 (Helicopters), the company operations manual (COM) must contain several elements, including "operating weather minima and applicable requirements for IFR [instrument flight rules], VFR, VFR at night and VFR over-the-top, including alternate aerodrome requirements."[12]

In this case, the COM provides the VFR weather minima stipulated in the CARs,[13] as required by the Standard, but it also contains a policy on weather conditions that CHL had implemented several years earlier.

This policy[14] states that:

> No Flights shall depart a Company Base or an Airport when reported weather conditions are below 600'– 3* miles unless approved by the Base Manager or the Director of Flight Operations.

*Weather Equivalents Table	
Ceiling (Feet)	**Visibility (NM [nautical miles])**
600	3
700	2
800	1

For local flight operations, the policy states that:

> a) While it is legal to continue flight operations at less than 1-mile visibility, Normal Company Flight Operations will cease when weather conditions [read: visibility] drop below 1 mile. Specific Approvals contained on the AOC which allow for flight with less than 1-mile visibility shall only be used to recover personnel to Base, Camp or for emergency flights approved by Management.
>
> b) No new operations are to be started when the weather is below 1 mile.
>
> c) The Pilot should be familiar with the area/route, and
>
> d) The weather should be forecast to improve, or the obscuring weather phenomenon is forecasted to be temporary in nature with the likelihood of the lower weather conditions to be brief in duration.

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11 Transport Canada, SOR/96–433, *Canadian Aviation Regulations*, Standard 722, paragraph 722.17(2)(d).

12 Ibid., Standard 723 (Helicopters), paragraph 723.105(1)(k).

13 Ibid., sections 602.114 and 602.115.

14 Canadian Helicopters Limited – Hélicoptères Canadiens Limitée, *Flight Operations Manual* – Part I (12 December 2022, Amendment No. r13), paragraph 4.7.7: Weather Policy - VFR – Non - EMS, p. 4-30.

> e) Distance to be traveled, fuel available, alternate landing areas and daylight hours available to complete the trip.[15, 16]

Paragraph a) of the policy refers to "Normal Company Flight Operations," but these are not defined in the COM. During the investigation, CHL stated that a flight operation is considered to be "normal" when weather conditions are not likely to have an impact on activities or do not pose an additional flight safety risk. The company expects flights to cease when visibility is less than 1 mile, subject to exceptions.

The company's AOC includes a special authorization regarding minimum flight visibility for daytime VFR flights conducted by its helicopters in uncontrolled airspace. This special authorization allows VFR flights to be conducted if the visibility is between 1 and ½ SM. Given that section 723.28 of CARs Standard 723 (Helicopters) requires that the COM contain operational procedures to be followed in such a situation, CHL has included the following procedure in its COM:

> a) Prior to commencement of a flight where flight visibility is likely to be less than one mile but not less than ½ mile, the PIC [pilot in command] shall comply with the following:
>
> i Check for practical alternatives (delaying or re-routing the flight) to avoid the area where the lower limits will be used, if unable;
>
> ii Advise customer of possible turn back or re-routing to other destination while enroute and confirm which will be more acceptable;
>
> iii Choose the route which provides the best navigation features (Power lines, railroad…) considering the weather forecast. Bearing in mind that you might not be the only one on that track, report your position frequently on the appropriate frequency;
>
> iv Assess the route for obstacles, rising ground, large body of water, fog producing surfaces and in winter, surfaces conducive to whiteout conditions;
>
> v Confirm that wind conditions and aircraft weight are such that a reduced airspeed could be maintained safely, use VNE [never exceed speed] minus 20% or a lesser speed if required;
>
> vi Assess the weather conditions with respect to precipitation which might reduce the visibility;
>
> vii Make sure that destination or alternate aerodrome shall be arrived at before darkness, which might set in before official night; and
>
> viii Consider the restriction to communication with a ground station or flight following when flying at low altitude.[17]

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15 The company expected pilots to use this subsection of the policy when they departed from a location where weather information was not precise enough to use the ceiling and visibility table provided in the policy.

16 Canadian Helicopters Limited – Hélicoptères Canadiens Limitée, *Flight Operations Manual* – Part I (12 December 2022, Amendment No. r13), paragraph 4.7.7: Weather Policy - VFR – Non - EMS, pp. 4-30 and 4-31.

17 Ibid., paragraph 4.7.13: Reduced Day VFR visibility, p. 4-33.

In this occurrence, the weather conditions at Port-Cartier at take-off met the ceiling and visibility minima stated in CHL's weather conditions policy.

1.17.1.2 Reduced-visibility flight operations training

At CHL, ground school training on reduced-visibility flight operations is given by a company instructor who uses a PowerPoint presentation to cover the various topics required by the CARs standard, such as regulations, the weather conditions policy, and the reduced visibility and inadvertent flight into IMC procedures. A video entitled "56 Seconds to Live," produced by the United States Helicopter Safety Team (USHST),[18] is also presented during the training.

The presentation clearly states that in accordance with its AOC and its special authorization, the company is authorized to conduct flight operations in uncontrolled airspace when visibility is between 1 and ½ SM. The presentation also indicates which conditions apply to be able to use this special authorization. In addition, it reminds pilots that departures are not authorized if the weather minima stated in its policy are not met.

The investigation was unable to determine whether the verbal explanations given during the training made it clear to the pilots that the company did not allow them to fly under the AOC's special authorization for reduced visibility. However, this restriction is not clear when reading the presentation.

A large part of the annual training on reduced-visibility flight operations focusses on IMC avoidance, but it also includes flight training on techniques such as slow descent and level 180°-turn using only instruments. Flight training also includes recovery from unusual attitudes.

The occurrence pilot had completed ground school and practical training for reduced-visibility flight operations in March 2022. Having completed the necessary training and met the conditions stipulated in the company's AOC special authorization, the pilot understood that he could continue with the flight if visibility was temporarily between 1 and ½ SM while enroute.

1.18 Additional information

1.18.1 Human factors issues

1.18.1.1 Visual information and spatial awareness

Pilots flying VFR primarily use available visual information to determine their position and their movement in space. Visual information includes visual references to the surface and the speed at which the surface passes by (peripheral vision). However, this information is not always reliable due to optical illusions.

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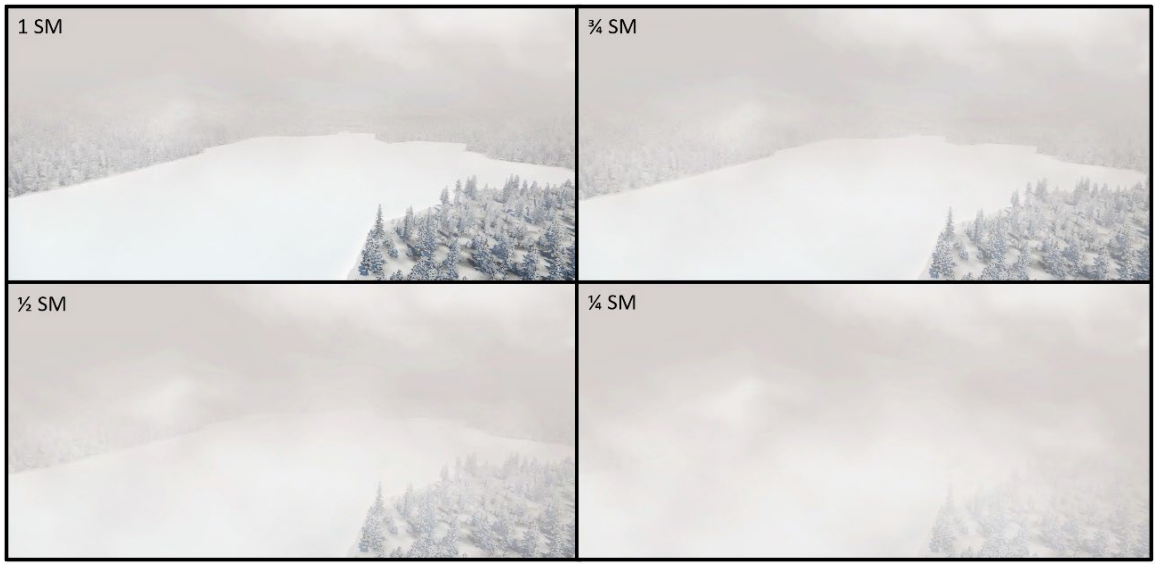
[18] United States Helicopter Safety Team, "56 Seconds to Live" video, at ushst.org/ihsf-featured-safety-videos/ (last accessed on 27 February 2025).

Spatial awareness is a person's ability to be aware of the relationship between themselves and the environment around them. The higher the quality of the visual information, the more accurate a pilot's spatial awareness will be. Conversely, if the visual information is of poor quality, as it is in reduced-visibility conditions when flying over snow-covered terrain or in flat-light conditions, a pilot's spatial awareness may be altered without it being recognized.

Although permitted by regulation, visibility between 1 and ½ SM is insufficient to provide good quality visual information in every case. In the winter, even a visibility of 3 SM may be insufficient to provide good quality visual information in flat-light conditions over a treeless area. In other words, even with the minimum visibility required by regulation, the visual information will not necessarily be of good enough quality to conduct the flight safely.

Figure 5 shows simulated views from the cockpit under various visibility conditions (1, ¾, ½, and ¼ SM), when the helicopter was about to begin flying over the lake where the accident took place, at a height of 200 feet AGL. Before crossing the lake, the pilot had estimated that visibility was approximately ¾ SM.

Figure 5. Simulated views from the cockpit when the occurrence aircraft was at a height of 200 feet above ground level over the southeast shore in the northern part of Vallillee Lake, with a ceiling of 250 feet above ground level, and visibilities of 1, ¾, ½, and ¼ statute miles (Source: TSB)



1.18.1.2 Memory and selection of a course of action

In highly practised situations (such as an autorotation),long-term memory (i.e. the schema) determines a person's expectations of the situation, according to their previous experience and training. The activation of schemas can lead to discordance when a schema and

situation do not match.[19] When people receive information contrary to their expectations, their performance tends to be slow or inappropriate.[20]

1.18.1.2.1 Selecting a course of action in a normal situation

In actual flying situations, pilots generally use their experience and knowledge to rapidly categorize the situation they are experiencing to develop a mental model[21] and to select a course of action accordingly.[22] The course of action is therefore selected based on how the scenario unfolded in the past and not necessarily based on the current situation. In that case, the action taken may not be appropriate if the scenario experienced in the past did not turn out as expected. In addition, mental models can lead pilots to have (unconscious) expectations about how the current situation will unfold. Given that mental models are resistant to change, they can reinforce the feeling that the selected course of action will lead to the expected outcome even when signs indicate that the current situation is different from the previous situations that created the mental model.

In this occurrence, the pilot continued with the flight because he expected the ceiling and visibility to improve, as was his experience in this area in the past. He also thought he could return to the Dog rail bypass or land at any time if conditions further deteriorated, as was also his experience in other locations.

1.18.1.2.2 Selecting a course of action in an emergency

During an in-flight emergency, when workload increases rapidly and reaction time is short, the choice of a course of action is not determined using the same mental process. If the emergency faced by the pilots is one of the emergency scenarios stored in their long-term memory through recurrent training, they will choose a course of action based on what they have learned for such an emergency, and will apply it automatically.

For all other emergencies, the initial reaction will be based on the working memory (short-term memory, acquired through practice), while the situation is analyzed and a solution is found. Given the heavy workload and short reaction time available, it is highly likely that the analysis will be partial or incorrect and lead to the selection of an inappropriate course of action.

In this occurrence, loss of visual references was not part of the emergency scenarios stored in long-term memory, even though the subject is discussed in pilots' annual ground training. Switching from VFR to IFR flight not only requires changing the focus from outside the aircraft to inside the cockpit, it also involves prior planning that cannot be done in an

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19 K. Smith and P.A. Hancock, "Situation awareness in adaptive, externally directed consciousness," in *Human Factors*, Vol. 37, No. 1 (1995), pp. 137–148.

20 G.J. Alexander and H. Lunenfeld, "Driver expectancy in highway design and traffic operations," in the U.S. Department of Transportation report No. FHWA-TO-86-1 (01 May 1986).

21 Mental models are internal representations that enable a person to describe, explain and predict events or situations in their environment.

22 G. Klein, "Naturalistic decision making," in *Human Factors,* Vol. 50, No. 3 (June 2008), pp. 456–460.

emergency. When the pilot lost his visual references, he began searching for others to maintain flight control and land.

1.18.2 Inadvertent flight into instrument meteorological conditions

1.18.2.1 Helicopter Association International

In its document entitled *HAI Decision-Making and IIMC*, Helicopter Association International (HAI) indicates the following:

> It is important to understand that IMC is not simply being in clouds and VMC is not simply being able to see the ground. **IMC is anything less than the minimum VMC** required within VFR within a particular class of airspace[23] [emphasis in the original].

In the same document, HAI also states that "[a]ny reduction in the application of the VFR is considered an **intentional deviation from VFR, which could lead to an unplanned flight into IMC** […]"[24] [emphasis in the original]. Furthermore, although regulations are clear on the minimum conditions required for a flight to be conducted under VFR, once in the air, if weather conditions change, pilots' perception and estimation of the deterioration or improvement of conditions are no longer as clear and become subjective.[25] For example, assessing distances while in flight (visibility and distance from cloud), which is the only thing that differentiates VMC from IMC in the CARs, is influenced, among other things, by the pilot's experience, the altitude being flown, the presence of precipitation, and speed. The subjectivity of this assessment is one of the factors that can reduce the effectiveness of the regulations, which are designed to prevent inadvertent flight into IMC (IIMC).

HAI proposes the use of enroute decision triggers (EDTs) to avoid an IIMC event before the possibility of encountering it. This concept of EDTs is based on determining a set of limits, such as indicated airspeed and height, that can be integrated into the company's procedures. The goal is to trigger pilots to make a decision and take action to correct the situation regardless of their personal comfort level in deteriorating weather conditions or passenger preference.[26]

Finally, HAI indicates that, in general, a VFR pilot flying a helicopter equipped for VFR flight should avoid IMC and land. In extreme cases, it is preferable to hover close to the ground using a visual reference until the visibility improves enough to allow for landing.

1.18.3 TSB recommendations

The risks and hazards associated with continuing VFR flights in IMC have been long recognized by air operators and TC alike.

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23 Helicopter Association International, *HAI Decision-Making and IIMC – A Training Reference Guide for Aircrews* (September 2021), Section 3.3: What Is IMC, p. 16.

24 Ibid., Section 3.1: What Are VFR?, p. 14.

25 Ibid., Section 3.4: Minimum VMC and HAI VFR Recommended Best Practices, p, 20.

26 Ibid., Section 3.5: Enroute Decision Triggers (EDTs) and Personal Minimums, p. 22.

Published over 30 years ago, the TSB's Aviation Safety Study 90-SP002 report[27] indicated that accidents in which the aircraft was operated under VFR in adverse weather conditions occur regularly, claiming a disproportionately high number of fatalities each year. They involve professional pilots, private pilots, and business pilots who fly general aviation aircraft and chartered commercial aircraft, including fixed-wing aircraft and helicopters.

To date, TC has not taken the action necessary to respond to the TSB's 3 recommendations that apply to commercial rotary-wing aircraft, which were issued in the report. Therefore, in its last assessment of TC's responses to these recommendations in March 2024, the TSB assessed that the responses were unsatisfactory and changed the recommendations' status to "dormant".[28]

In its Air Transportation Safety Investigation Report A21C0038, published in February 2024, on an occurrence involving an AS350 B2 helicopter colliding with terrain on Griffith Island, Nunavut, where the pilot encountered IIMC, the TSB issued 4 recommendations to TC, which recommend that the Department of Transport:

- require commercial helicopter operators to ensure pilots possess the skills necessary to recover from IIMC (A24-01);[29]
- require commercial helicopter operators to implement technology that will assist pilots with the avoidance of, and recovery from, IIMC (A24-02);[30]
- require operators conducting single-pilot operations under Subpart 604 and Part VII of the CARs to develop standard operating procedures based on corporate knowledge and industry best practices to support pilot decision making (A24-03);[31]
- enhance the requirements for helicopter operators that conduct reduced-visibility operations in uncontrolled airspace to ensure that pilots have an acceptable level of protection against IIMC accidents (A24-04).[32]

The TSB also encourages operators to go above and beyond existing regulations, without waiting for regulatory amendments by TC to enhance the safety of their operations.

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27 Transportation Safety Board of Canada, *Safety issue investigation (SII) – VFR flight into adverse weather* (13 November 1990), at https://www.tsb.gc.ca/eng/rapports-reports/aviation/etudes-studies/90sp002/90sp002.html.

28 TSB recommendations A90-84, A90-83, and A90-81, at https://www.tsb.gc.ca/eng/recommandations-recommendations/aviation/index.html.

29 TSB Recommendation A24-01: Recovery from inadvertent flight into instrument meteorological conditions, at https://www.bst.gc.ca/eng/recommandations-recommendations/aviation/2024/rec-a2401.html.

30 TSB Recommendation A24-02: Technology as a defence against inadvertent flight into instrument meteorological conditions accidents, at https://www.bst.gc.ca/eng/recommandations-recommendations/aviation/2024/rec-a2402.html.

31 TSB Recommendation A24-03: Standard operating procedures for single-pilot commercial operations, at https://www.bst.gc.ca/eng/recommandations-recommendations/aviation/2024/rec-a2403.html.

32 TSB Recommendation A24-04: Enhanced risk mitigation for reduced-visibility operations in uncontrolled airspace, at https://www.bst.gc.ca/eng/recommandations-recommendations/aviation/2024/rec-a2404.html.

2.0 ANALYSIS

The occurrence pilot held the appropriate licence and ratings for the flight in accordance with existing regulations, and there was no indication that the pilot's performance was degraded by fatigue. There was also no indication that the helicopter had a system malfunction that may have played a role in the occurrence.

The prevailing weather conditions in the vicinity of Sept-Îles, Quebec, at the time of departure were suitable for a visual flight rules (VFR) flight. However, they degraded to the point where they became instrument meteorological conditions (IMC) approximately 30 minutes later.

The risks involved with inadvertent flight into IMC (IIMC) are known. Despite the industry's efforts to make pilots aware of these risks and to train pilots to avoid finding themselves in this situation, or to know how to recover from it, the number of collisions with terrain after a loss of adequate visual references remains high.

Consequently, this analysis will focus on IIMC, the loss of visual references and how to recover from IIMC, operational restrictions, and decision-making support.

2.1 Inadvertent flight into instrument meteorological conditions

For approximately 4 years, the pilot had been assigned to transporting ArcelorMittal workers between Port-Cartier, Quebec, and the Fire Lake mine, Quebec. He was very familiar with the flight path along the railway that he flew on the day of the occurrence. He was also very familiar with the local weather phenomena that were possible along this path.

The relevant graphic area forecast was consulted during flight planning to determine the weather conditions forecasted for the day, and had not given rise to any concerns. According to the forecast, the visibility would be greater than 6 statute miles (SM) and patchy clouds could lower the ceiling to 1200 feet above ground level (AGL). Isolated towering cumulus clouds, which could cause light snow showers and a visibility of 2 SM, were also expected in the same cloud mass, but much further north of the planned flight path.

Approximately 20 minutes after takeoff, light snow showers began, reducing the visibility to less than 3 SM and lowering the cloud ceiling. Approximately 10 minutes later, the weather conditions were different from what had been forecast; the ceiling continued to lower and the visibility was decreasing ahead.

A localized weather phenomenon that reduced the visibility and lowered the ceiling had been observed on several occasions in this area.

The pilot knew that he was complying with the conditions of the company's air operator certificate, more specifically those of the reduced-visibility special authorization allowing him to fly VFR in IMC, in other words, with a minimum visibility of ½ SM clear of cloud (see section 2.3, *Operational restrictions*). He slowed down and began a descent to fly below 500 feet AGL as he continued on his route. He remained on the east side of the railway,

where the terrain was the lowest, and headed toward an area where the ceiling and visibility typically improved.

Finding as to causes and contributing factors

The weather forecasts did not mention a visibility of less than 2 SM, which reinforced the pilot's impression that the reduced visibility and the ceiling height he encountered were due to a localized weather phenomenon. Since he was complying with the conditions of the special authorization, which allowed low-visibility flight operations, the pilot continued the flight into IMC.

According to the weather analysis report prepared by Environment and Climate Change Canada, the surface trough predicted for the south shore of the St. Lawrence River in the graphic area forecast occurred on the north shore and was moving eastward. Fifty minutes before the helicopter arrived in the vicinity of Vallillee Lake, Quebec, convection was at its peak in this area. The cloud cover was blocking the pilot's view of the convective clouds; therefore, he could not see the mature convective cells, which would have warned him of imminent snow showers, as he approached Vallillee Lake.

The snow showers suddenly intensified and visibility rapidly decreased to approximately ¾ SM.

When the helicopter reached the south shore of the small lake connected to Vallillee Lake, it had a ground speed of 42 mph and was at a height of 210 feet AGL. At that point, according to the information collected during the investigation, the visibility was still estimated to be around ¾ SM. Confident that conditions were going to improve soon, and seeing the entire contour of the lake and a bit beyond, the pilot continued the flight to cross over the small lake. He had planned to turn back if necessary and land at the Dog rail bypass if the weather conditions deteriorated too severely.

Flight data collected from the satellite flight-tracking system indicate that the helicopter was in a constant descent, even before flying over the small lake. The investigation was unable to determine whether the descent was noticed by the pilot after he began crossing the lake.

Even when visibility meets regulatory requirements and visual references are visible during a flight, it is possible for flight safety to be compromised in situations of low visibility or when flying over a surface with no contrast. These 2 situations decrease the quality of the visual information pilots receive and affect their spatial awareness because their ability to accurately determine height, distance, and speed visually is altered. Complying with regulations may not be enough to guarantee safety.

Finding as to causes and contributing factors

Seeing the entire contour of the lake and confident that visibility was going to improve, the pilot continued flying in the snow shower while he was descending over the lake. His spatial

awareness, which had deteriorated without him knowing, affected his ability to visually determine his height.

2.2 Loss of visual references and method for exiting instrument meteorological conditions

One of the risks of continuing a VFR flight into IMC is the sudden loss of visual references. In that case, spatial disorientation would lead to a loss of control of the aircraft if appropriate action is not taken immediately. This is an emergency that any pilot may encounter, regardless of their experience. In the occurrence flight, the pilot believed that he would be able to detect the imminent loss of visual references and turn back or land before the situation arose. However, approximately 5 seconds after he started crossing the snow-covered lake, the pilot suddenly lost all visual references in front of him, likely due to the sudden onset of a heavy snow shower.

According to the weather analysis report prepared by Environment and Climate Change Canada at the TSB's request, the maximum snowfall rate was 3 to 4 cm/h in the area, which suggests a sudden drop in visibility to ¼ SM. Although the lake was small and visibility was not zero, the trees on the shore only needed to be at a greater distance than the visibility at the time to result in the loss of visual references.

If references are lost completely, Canadian Helicopters Limited – Hélicoptères Canadiens Limitée (CHL) recommends switching from VFR flight to IFR flight to exit IMC as a last resort. Even though annual training includes in-flight exercises using instruments only, the switch to IFR is not part of the emergency scenarios practised during this training, which is designed to ingrain in pilots' long-term memory the immediate actions to be taken if an engine failure occurs, for example.

Switching from VFR flight to IFR flight not only involves changing the focus from outside the aircraft to inside the cockpit, it also involves prior planning that cannot be done in an emergency. In low-level flight, if a pilot who is not rated for IFR flight is flying a helicopter that is not IFR-certified and has little or no instruments for navigating in IFR conditions, switching from VFR flight to IFR flight is difficult to consider as an option.

Also, pilots who find themselves in an emergency that is not one of the scenarios recorded in their long-term memory use their short-term working memory to respond. In this occurrence, the essential element of the working memory needed to maintain control of the flight and land was being able to see something.

Knowing that a left turn was not an option because the ground rose, and seeing trees on the shore to the right, the pilot relied on his visual references and began a 180° turn to the right. While he was in the turn, and believing that he had maintained a height of approximately 300 feet, he momentarily lost his visual references, but then was able to see other trees and attempted to maintain control by relying on these new references.

However, even if a pilot can see something, the visual references are not necessarily good enough to maintain effective spatial orientation and prevent controlled flight into terrain.

Before striking the frozen surface of the lake, the occurrence pilot could see trees, but the quality of the visual information available to him did not allow him to properly assess his height or speed and prevent the controlled flight into terrain.

Finding as to causes and contributing factors

A third of the way across the small snow-covered lake, the pilot lost the visual references ahead of him due to the snow shower that had suddenly intensified. He then immediately turned to the right, where he could momentarily see trees as the descent continued, resulting in the helicopter striking the lake's frozen surface.

2.3 Operational restrictions

CHL had a special authorization regarding minimum flight visibility for daytime VFR flights conducted by its helicopters in uncontrolled airspace. This authorization allowed pilots who met the stipulated conditions to continue a VFR flight if the visibility was between 1 SM and ½ SM. The occurrence pilot met the conditions of the special authorization.

Although CHL could use this authorization for all of its VFR operations, it had implemented stricter operational restrictions for its VFR flights, subject to exceptions, to reduce the likelihood of IIMC accidents. CHL's policy on VFR flight weather conditions indicated to cease normal flight operations if visibility was below 1 mile.

The company operations manual (COM) discussed reduced-visibility flight operations in various locations and included both regulatory requirements and those relevant to the special authorization, along with the company's policy (operational restrictions). Including information in a manual is not always enough to ensure the requirements are met. The requirements must be clear and pilots must know which restriction or authorization supersedes the other, and under which circumstances either applies.

CHL provided instructor-led ground school training on reduced-visibility flight operations to pilots annually, which covered all of these aspects. A PowerPoint presentation was used as support for the training. The occurrence pilot was familiar with the requirements for flying in visibilities down to ½ mile and these requirements had been presented clearly in the training material. However, the application of the 1-mile operational restriction was not understood as clearly: the pilot believed that he could continue his flight if visibility did not drop below ½ mile because he had received the training required for the special authorization. The investigation was unable to determine whether the other company pilots had the same interpretation as the occurrence pilot. However, it is not clear in the PowerPoint presentation nor in the COM that the special authorization must only be used for the exceptions stated in the company's policy.

The issue with incorrectly interpreting company instructions or procedures is one that the TSB has already raised, for various modes of transportation. For example, in its Rail Transportation Safety Investigation Report R21H0114, the TSB emphasized the importance of employees fully understanding what it expected of them when they need to apply

essential safety procedures. In order to achieve that goal, training, audits, and oversight must be effective.

Finding as to risk

If air operators decide to implement safety measures in addition to those required by regulations, but the inclusion of these measures into manuals and training is not done in a way that ensures that they are properly understood, there is an increased risk that the measures will not be applied, thereby negating the benefits that they were intended to provide.

2.4 Decision-making support

It has been over 30 years since the TSB first pointed out that continuing a VFR flight into IMC causes accidents that are often fatal. Transport Canada (TC) has not taken the necessary action to respond to the TSB's recommendations that apply to rotary-wing aircraft on commercial flights. Complying with regulations does not necessarily guarantee flight safety and cannot be the only criterion in deciding whether or not to continue a flight in deteriorating weather conditions. The TSB encourages operators to go above and beyond existing regulations, without waiting for regulatory amendments by TC to enhance the safety of their operations.

As the TSB stated in its Air Transportation Safety Investigation Report A21C0038, the final decision to terminate a flight or to turn back ultimately lies with the pilot, which means that the trigger for this decision is personal. Although annual pilot training provided by companies tends to offer guidelines to be followed to ensure the safety of operations, the fact remains that the final decision is subjective. It can be difficult, therefore, for an air operator to assess whether guidelines are actually being followed as intended, particularly for VFR flights during which weather conditions deteriorate.

To assist operators in establishing a frame of reference for operational decision making and support pilots in making decisions, Helicopter Association International (HAI) suggests using enroute decision triggers, such as airspeed and height, to avoid pilots finding themselves in weather conditions that could lead to IIMC. The goal is to trigger a need within pilots to take action to correct the situation regardless of their personal comfort level in the deteriorating weather conditions.

Finding as to risk

If the decision to continue a VFR flight when the weather conditions deteriorate is based on subjective elements, it is possible that flights will continue into conditions that are no longer safe, which increases the risk of accidents related to flying under VFR in IMC.

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. The weather forecasts did not mention a visibility of less than 2 statute miles, which reinforced the pilot's impression that the reduced visibility and the ceiling height he encountered were due to a localized weather phenomenon. Since he was complying with the conditions of the special authorization, which allowed low-visibility flight operations, the pilot continued the flight into instrument meteorological conditions.

2. Seeing the entire contour of the lake and confident that visibility was going to improve, the pilot continued flying in the snow shower while he was descending over the lake. His spatial awareness, which had deteriorated without him knowing, affected his ability to visually determine his height.

3. A third of the way across the small snow-covered lake, the pilot lost the visual references ahead of him due to the snow shower that had suddenly intensified. He then immediately turned to the right, where he could momentarily see trees as the descent continued, resulting in the helicopter striking the lake's frozen surface.

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 air operators decide to implement safety measures in addition to those required by regulations, but the inclusion of these measures into manuals and training is not done in a way that ensures that they are properly understood, there is an increased risk that the measures will not be applied, thereby negating the benefits that they were intended to provide.

2. If the decision to continue a visual flight rules flight when the weather conditions deteriorate is based on subjective elements, it is possible that flights will continue into conditions that are no longer safe, which increases the risk of accidents related to flying under visual flight rules in instrument meteorological conditions.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 Canadian Helicopters Limited – Hélicoptères Canadiens Limitée

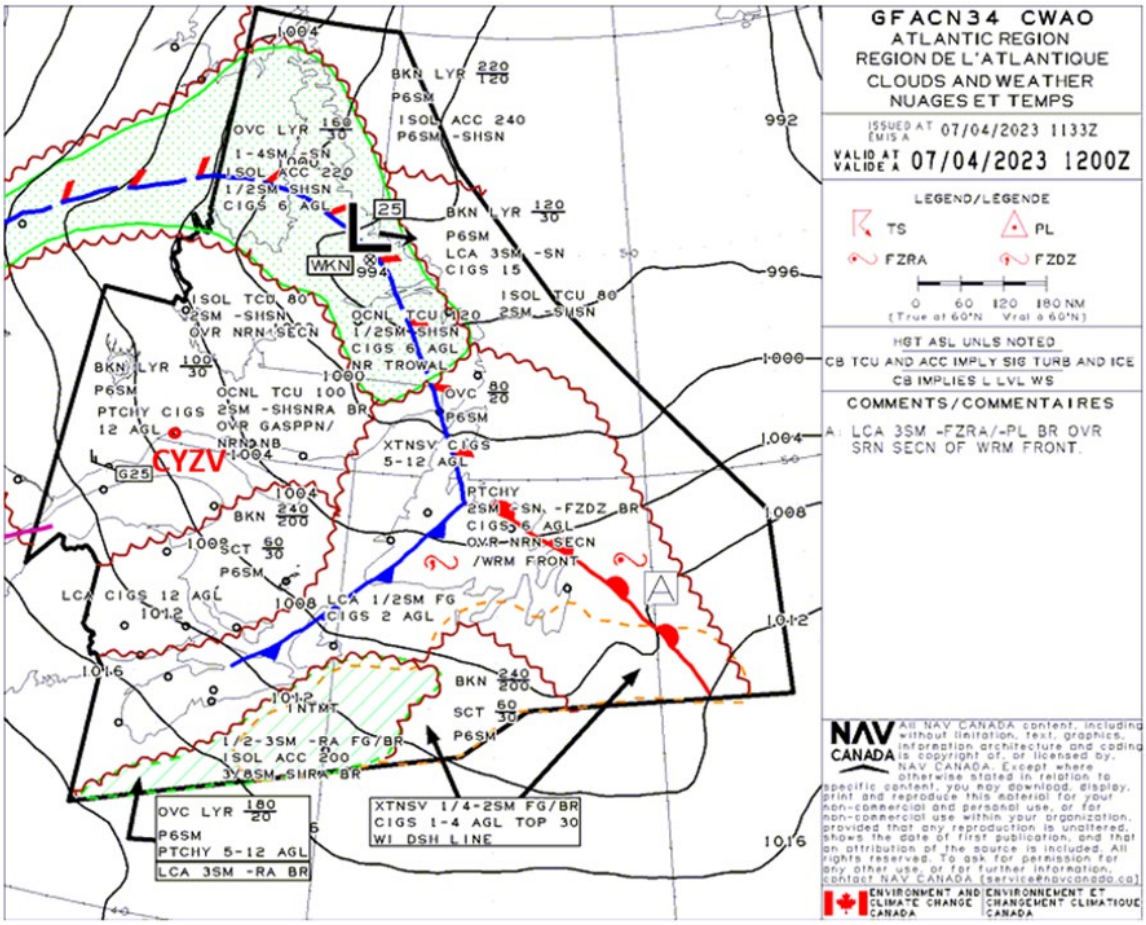
Following the occurrence, Canadian Helicopters Limited – Hélicoptères Canadiens Limitée took the following safety action:

- Several articles were published in the company newsletter regarding controlled flight into terrain, continuation bias, and expectation bias.
- The flight operations manager published a memo clarifying the company weather limits.
- On 22 June 2023, an operations and safety update meeting was held for all company personnel during which, several topics relevant to the occurrence were discussed.
- The occurrence accident detailed in this report is now being used as an example of low-visibility operations for both initial and recurrent training to familiarize pilots with the issue and encourage them to be vigilant.
- The United States Helicopter Safety Team-sanctioned video "56 Seconds to Live," on inadvertent flight into instrument meteorological conditions, has been incorporated into the training for all pilots. A new section on whiteout conditions has also been added to the training.
- The specific sections of the flight operations manual governing reduced day visual flight rules operations and weather limitations have been reviewed, and changes have been drafted and submitted to Transport Canada for approval.
- Lessons learned from this occurrence have been shared with all relevant stakeholders.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 29 January 2025. It was officially released on 21 March 2025.

APPENDICES

Appendix A – Clouds and Weather Chart from the graphic area forecast for the Atlantic Region



Source: NAV CANADA, with TSB annotations