Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A10Q0132

LOSS OF VISUAL REFERENCE WITH THE GROUND, LOSS OF CONTROL, COLLISION WITH TERRAIN
HÉLI-EXCEL INC.
EUROCOPTER AS350-BA (HELICOPTER) C-GIYR
SEPT-ÎLES, QUEBEC, 22 NM N
17 AUGUST 2010

Canada

Aviation Investigation Report

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Héli-Excel Inc.
Eurocopter AS350-BA (Helicopter) C-GIYR
Sept-Îles, Quebec, 22 nm N

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Report Number A10Q0132

Synopsis

At 1111, Eastern Daylight Time, the Eurocopter AS350-BA (registration C-GIYR, serial number 2299), operated by Héli-Excel Inc., departed from Sept-Îles (Quebec) under visual flight rules for Poste Montagnais (Quebec), approximately 100 nm north of Sept-Îles. Fifty minutes after take-off the company's flight-following system indicated that the helicopter was 22 nm north of Sept-Îles and was not moving. A search was conducted and the wreckage was found on a plateau. There was no fire but the aircraft had been destroyed on impact. The pilot and the 3 passengers aboard were fatally injured. No distress signal was received from the emergency locator transmitter.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

On 13 August 2010, Héli-Excel Inc. received a charter request from Hydro-Québec for an AS350-B2 helicopter to transport 4 passengers and 300 pounds of baggage from Sept-Îles to Poste Montagnais on 17 August 2010 (Figure 1). The helicopter would then be based at Poste Montagnais and used for inspection and maintenance of Hydro-Québec installations until 20 August 2010, at which point it would return to Sept-Îles.

Because an AS350-B2 was not available, Hydro-Québec agreed to use an AS350-BA, which had a maximum take-off weight 330 pounds less than the AS350-B2. It was agreed that some of the 300 pounds of baggage would be transported to Poste Montagnais and the remainder would be sent by plane. This agreement is not documented.

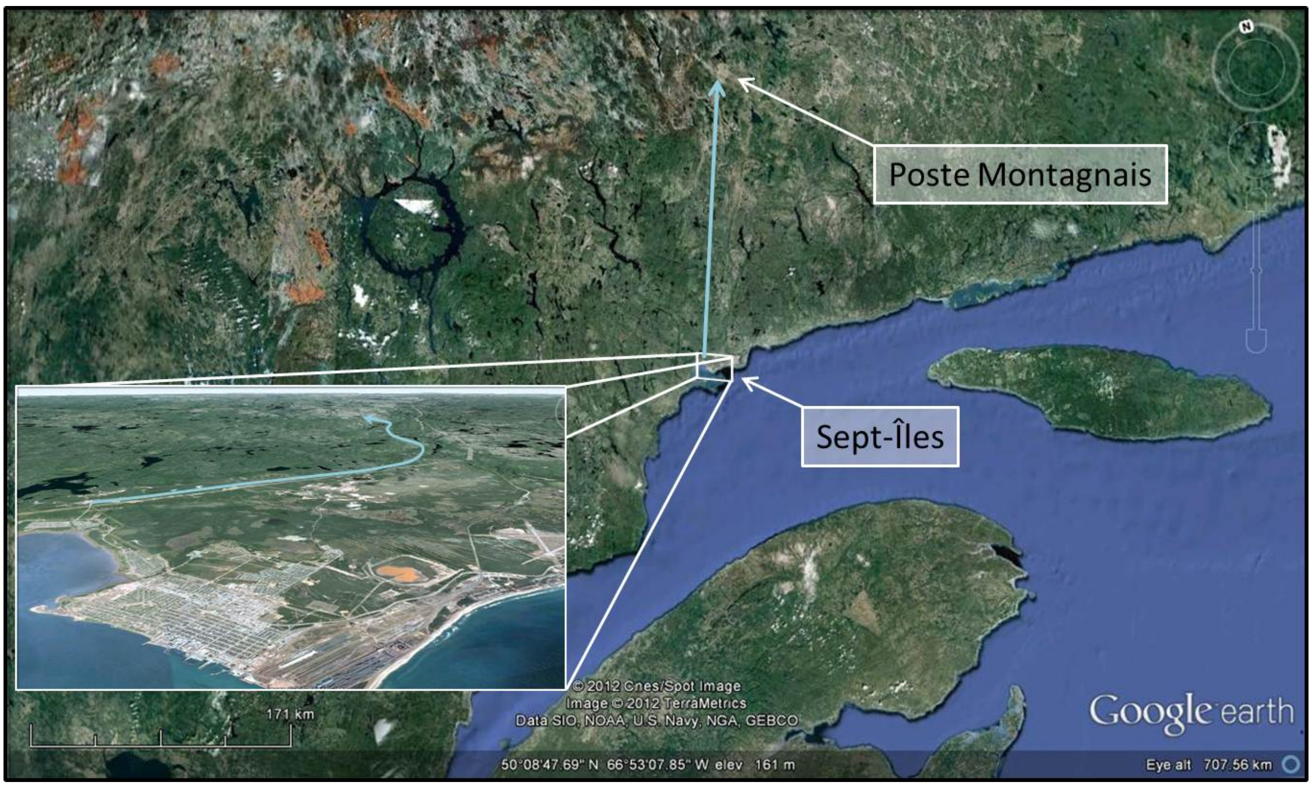

Figure 1. Satellite image showing area of the flight

Because of the weather conditions in the area—the mountain peaks were in the clouds—the aircraft could not follow a straight path over the terrain. The pilot therefore planned to follow the power lines in a northeasterly direction until the Moisie River. Once in the Moisie River valley, the pilot could then follow the railway tracks north to Poste Montagnais. The planned flight time was 1 hour, 15 minutes, and the pilot planned a 75% fuel load, i.e., approximately 750 pounds or 2 hours 30 minutes of flying time.

The flight plan[1] called for departure at 0930[2] from Sept-Îles with the AS350-BA (C-GIYR), 3 passengers, 300 pounds of baggage and a 75% fuel load. Arrival at Poste Montagnais was scheduled for 1130.

The passengers arrived at Héli-Excel's base at around 0800 with approximately 760 pounds of baggage. Because the weather conditions were not conducive to visual flight, the company's operations manager informed the pilot that the flight would be delayed. The pilot in turn informed the passengers and together they loaded the baggage, consisting mainly of work tools. Given the heavy weight of the tools, the pilot reduced the fuel load to 60%, i.e., 600 pounds or 2 hours' flying time.

At 0900, the pilot phoned Hydro-Québec's flight follower at Poste Montagnais for the latest weather report. According to the information obtained, the mountain peaks were above the cloud cover and the aircraft would have to fly in the valleys.

At 0915, the pilot informed the company's operations manager that there was a lot of baggage. It was agreed that the excess would be transported by truck from Héli-Excel's base to the Sept-Îles airport where a plane was departing for Poste Montagnais at 1015.

At 1111, C-GIYR departed on a northeast heading, along the power lines, at reduced speed. Four minutes later, the pilot informed Hydro-Québec that the flight had taken off but might have to return to Sept-Îles because of the weather.

At 1121, the helicopter was flying in a northerly direction above the Moisie River, 150 feet above ground level (agl) at normal cruising speed.[3] At 1125, the pilot informed Hydro-Québec that he expected to arrive at Poste Montagnais at 1215.

At 1127, at the junction of the Nipissis River, the pilot remained above the Moisie River, which veers northwest, instead of following the railway tracks that run along the Nipissis River valley until Poste Montagnais (Figure 2). The helicopter was flying over the Moisie River at normal cruising speed, at an altitude of about 200 feet agl.

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1 Hydro-Québec flight plan used to track the flight

2 All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours) unless otherwise noted.

3 The normal cruise speed for these flights is approximately 100 knots.

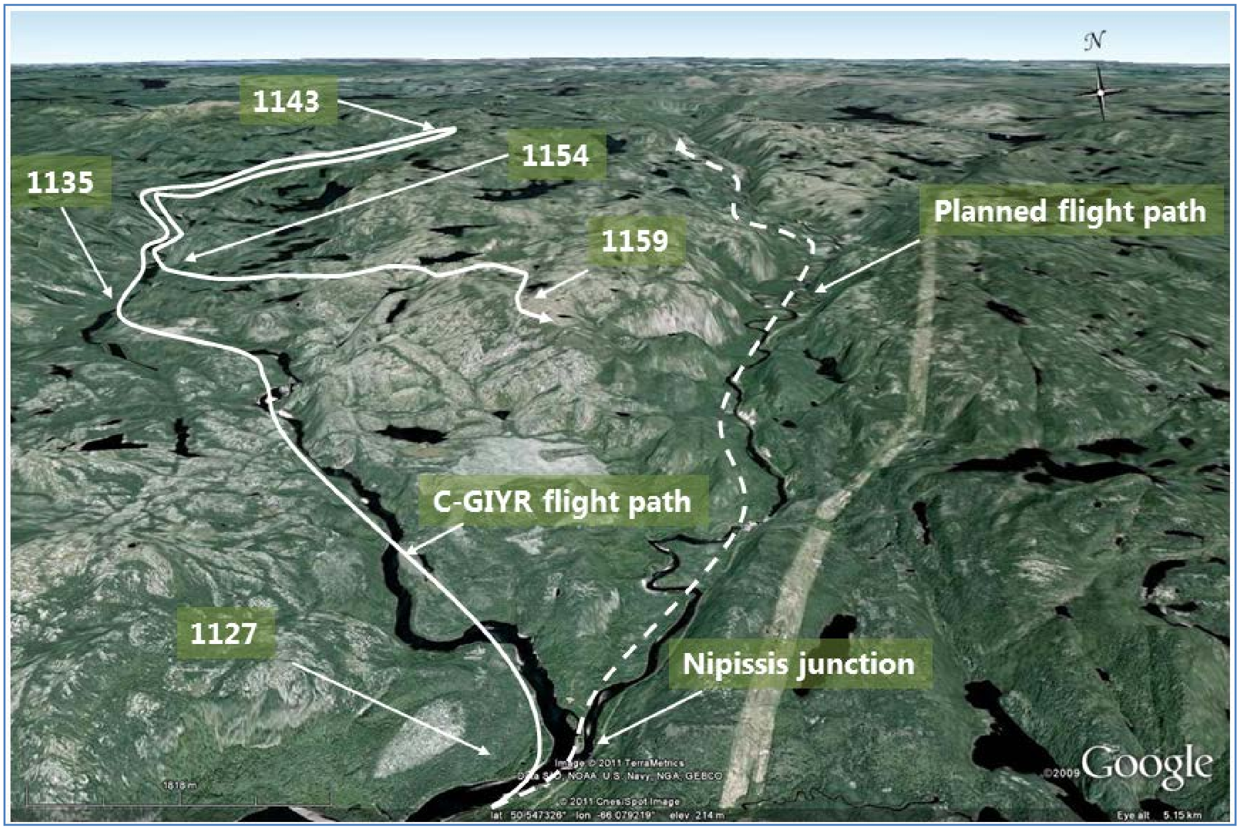

Figure 2. Satellite image of terrain overlaid with C-GIYR fight path from the Nipissis River junction

At 1135, the pilot stopped following the Moisie River and entered a valley to his right in a northeasterly direction toward Poste Montagnais. At 1143, he made a half-turn, returning to and following the Moisie River once again but in a southerly direction. The half-turn was made at an altitude of about 1900 feet above sea level (asl), where the mountain peaks are over 2000 feet.

At 1154, the helicopter was about 9 nautical miles (nm) north of the Nipissis River junction. The aircraft turned east, leaving the Moisie River valley, followed the rising terrain and a few minutes later reached a plateau that is at an altitude of approximately 1700 asl. At that point, the aircraft was about 80 feet agl at a ground speed of 38 knots.

At 1159, the helicopter flew over the peak of the plateau, still at about 80 feet agl, moving at an average ground speed of 26 knots. This is the last position transmitted by the satellite flight-following system.

At 1201:5, the helicopter reached the southeast edge of the plateau, where the ground quickly descends towards the Moisie River valley. The helicopter began climbing, levelling off at about 300 feet above the plateau while turning left; less than 4 seconds later it struck the ground at a steep angle, in a northwest direction (Figure 3). The accident occurred at 1201:37.

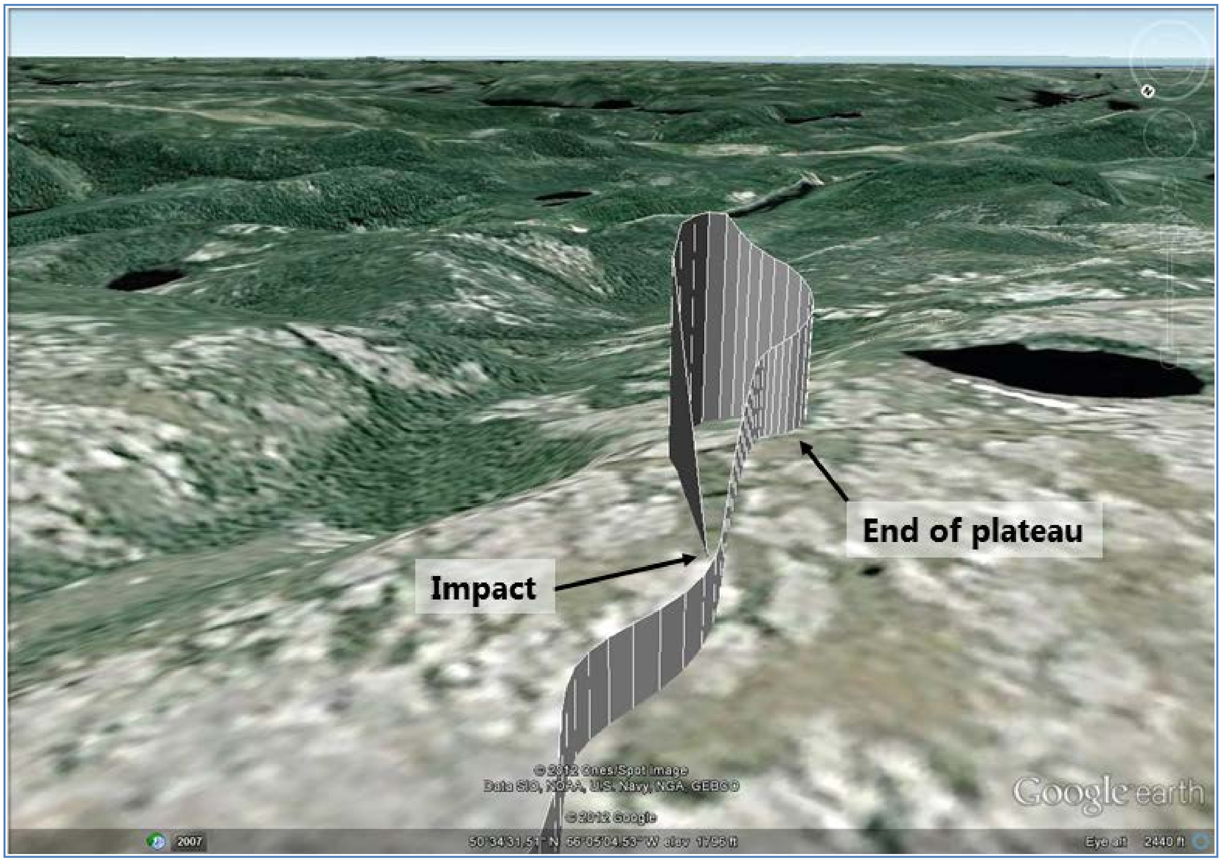

Figure 3. Satellite image of terrain overlaid with a flight profile showing the helicopter's position at 1-second intervals preceding impact

At 1205, Hydro-Québec's flight follower at Poste Montagnais noticed on the satellite flight-following system that C-GIYR had not moved since 1159. He contacted Héli-Excel's operations manager, who in turn contacted the Trenton Canadian Mission Control Centre (CMCC), which confirmed that it had not received any distress signal from C-GIYR's emergency locator transmitter (ELT).

At 1328, the operations manager took off from the Sept-Îles base and 14 minutes later found the wreckage of C-GIYR.

1.2 Deaths and Injuries

Table 1. Deaths and injuries

Injuries	Crew	Passengers	Others
Fatal	1	3	0
Serious	0	0	0
Light/None	0	0	0

None of the occupants survived the impact.

1.3 Aircraft Damage

The helicopter was completely destroyed on impact.

1.4 Other Damage

Approximately 187 litres of JET A-1 jet fuel were spilled.

1.5 Pilot Information

The pilot began his helicopter training in March 2007 and obtained his Canadian commercial pilot licence on 02 November 2007. He had logged 105.8 hours of flight time, including 39.3 hours as pilot-in-command.

The pilot was hired on 26 March 2008 by Héli-Excel in Sept-Îles as a gopher. He would sometimes fly the helicopters on ferry flights or other non-revenue flights. In 2008 and 2009, the pilot had logged about 66 hours of flight time with experienced pilots, including 20 hours on the AS350. In spring 2010, the pilot began his first season as a commercial pilot with Héli-Excel and received the ground and flight training required by the *Canadian Aviation Regulations* (CARs). On 21 June 2010, the pilot successfully completed his pilot proficiency check and aircraft type rating on the AS350.

The pilot was certified and qualified for the flight in accordance with existing regulations. At the time of the occurrence, the pilot had logged about 235 hours of flight time, including 113 hours as pilot-in-command.

The pilot had received, among other things, decision-making training, which involved viewing the slide presentation included in Transport Canada's (TC) educational package.[4] The slides go over the decision-making process, human performance factors, human error and risk management.

Because the pilot did not have the minimum experience required under the CARs' operations specifications for visual flight rules (VFR) flights in reduced visibility conditions, his minimum flight visibility requirement was one statute mile.

The company did not train the pilot on the following aspects nor was it required to do so by regulation:

- The dangers of VFR flights in instrument meteorological conditions (IMC)
- Flying in reduced visibility
- The dangers of loss of visual references
- Controlled flight into terrain (CFIT)
- Instrument training
- Recovery from an unusual attitude without visual references

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4 TP 13897, Transport Canada, Pilot Decision Making – PDM

The pilot had already flown to Poste Montagnais several times before. The flight was not considered difficult because railway tracks run along the Moisie and Nipissis rivers all the way to Poste Montagnais, and the helipads that were to be used are unobstructed.

The week before the accident, the pilot carried out 7 flights, totalling 5.9 hours. The morning of 17 August, the pilot was coming off 14 hours of rest before beginning his second day of work, which was preceded by 2 days off. Consequently, there is no evidence that the pilot was tired the day of the accident due to lack of sleep or a health issue.

1.6 Aircraft Information

C-GIYR was maintained by Héli-Excel's approved maintenance organization (AMO) in accordance with regulations and the current maintenance and inspection program. The aircraft had accumulated 5475.1 hours of flight. A 100-hour inspection was performed on 28 May 2010 and the helicopter had flown 81.7 hours since then.

The engine, a Turbomeca Arriel 1B (serial number 4816TEC), had a total time since new of 3831 hours at the time of the accident. An examination of the engine and its accessories did not reveal any anomaly before the impact that might have prevented it from operating normally. Vegetation was found inside the compressor intake chamber and the combustion chamber. The compressor blades and drive shafts connected to the power turbine exhibited deformation characteristic of an engine producing power at the time of impact. Examination of the engine instruments showed that the main rotor rpm was within normal range of operation and engine torque was at the allowable peak at the time of impact.

Examination of the flight controls revealed no evidence of pre-impact failure or malfunction.

The instrument panel with the integrated global positioning system (GPS),[5] annunciator panel, ELT, and components of the satellite tracking and data telemetry system[6] were all sent to the TSB Laboratory. The helicopter did not have an attitude indicator or a directional gyro, nor are these required by regulation for VFR flights. Examination of the GPS, the anemometer, vertical speed indicator, and altimeter revealed no useful information for the investigation.

The annunciator panel is composed of 18 indicators, each with 2 incandescent bulbs to alert the pilot of conditions requiring attention. Examination of the ENG P and BLEED VALVE filaments revealed that they were stretched, suggesting that they were on at the time of impact. As engine oil pressure, which is used to indicate engine torque, was at its peak at the time of impact, it is possible to conclude that the oil pressure was normal when the aircraft crashed. The BLEED VALVE indicator is lit green when the purge valve is open. At about 40 knots, the light remains illuminated and takes at least one second before going out when power is rapidly applied. Therefore, in the context of the last moments of the flight, the fact that these 2 indicators were on does not change the conclusion drawn following the disassembly, i.e., that the engine was producing power at the time of impact.

The Kannad AF-COMPACT (serial number 2620805-0135) ELT transmits on 121.5 MHz and 406 MHz. It is installed in the right rear baggage compartment and the antenna is positioned on

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5 GPS Garmin GNC 250XL

6 SkyNode, Latitude Technologies Corporation

top of the cabin, close to the engine air intake. The ELT, which was still connected to the antenna wire, showed no signs of damage, and the switch was set in ARM position .

When subjected to the force of impact, the ELT is activated and transmits a test signal. About 50 seconds after activation, the distress signal begins transmitting every 50 seconds. The COSPAS-SARSAT system[7] receives all ELT signals, including the test signal. However, the test signal is filtered and not forwarded to CMCC Trenton. Because the antenna was severed during the break-up, the distress signal did not reach COSPAS-SARSAT.

The satellite tracking and data telemetry system[8] installed on the helicopter records data every 4 seconds. The data are then transmitted by satellite to the Web server, which shows the position of the aircraft every 2 minutes on a map. The server data, including time, position and altitude, helped recreate the approximate path of the flight.

By reading the printed circuit board installed aboard C-GIYR, it was possible to pinpoint the position of the helicopter every 4 seconds for the last 7.5 minutes of flight. The calculation of this path as a function of the speed was then used to establish the position every second during the last minutes of flight (Figure 3).

The amount of fuel on board is displayed as a percentage of the fuel tank capacity (540 litres), i.e., approximately 1000 pounds[9] when full. Fuel consumption in flight is about 300 pounds per hour. When the amount of usable fuel drops to 104 pounds, which equals about 20 minutes of flight, the low fuel indicator lights up on the annunciator panel. This amount is the minimum 20-minute reserve required by the CARs.[10]

When it took off from the Sept-Îles base, C-GIYR was fuelled to 60% capacity, i.e., 600 pounds or enough for 2 hours of flying time, including the minimum 20-minute reserve.

1.6.1 Weight and Balance

Hydro-Québec's initial charter request was for an AS350-B2 to carry 4 passengers and 300 pounds of baggage. The AS350-B2 has an empty weight similar to that of the AS350-BA but a maximum allowable take-off weight of 330 pounds more, i.e., 4960 pounds. According to the AS350-B2 weight chart, with fuel tank at 60% capacity and 4 passengers on board, the aircraft can carry no more than 272 pounds of baggage.

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7 International Satellite System for Search and Rescue

8 SkyNode, Latitude Technologies Corporation

9 A litre of JET A1 weighs 1.85 pounds at 15 °C.

10 CAR 602.88(3)(*b*), Fuel Requirements

Because an AS350-B2 was not available, the request was modified for an AS350-BA with an agreement that an alternative would be provided to carry excess baggage. According to the weight chart of C-GIYR (AS350-BA), up to 50 pounds of baggage can be transported on a tank that is filled to 60% capacity, and with 4 passengers on board (Appendix C). With 4 passengers, the C-GIYR would be overweight by 250 pounds.

Table 2. Take-off weight calculation

Item	Weight (pounds)
C-GIYR light weight	2925.5
Survival kit	90
Fuel	599.4
Pilot	280
Passengers	561
Baggage	561.9
Total	5017.8

Although there is a scale inside the hangar, it was not used during loading. However, the investigation established that the passengers had a total of 761.9 pounds of baggage, i.e., 561.9 pounds recovered from the wreckage and weighed in Sept-Îles, and 200 pounds of baggage that was removed and sent by air to Poste Montagnais.

The pilot weighed 280 pounds. As the actual weight of the 3 passengers was not available, using an average weight[11] of 187 pounds for a man, in summer and without hand luggage, the take-off weight of C-GIYR was 5017.8 pounds (Table 2). The maximum allowable take-off weight of an AS350-BA (C-GIYR) is 4630 pounds.

1.7 *Weather Conditions*

The morning of the flight in question, the city of Sept-Îles was affected by an air flow from the river to the coast, causing local conditions of low clouds at 300 feet and reduced visibility of 1 sm in light drizzle and fog. Conditions were expected to improve after 1000.

The flight area, north of Sept-Îles, was cloudy due to an approaching cold front moving eastwards. The graphical area forecast (GFA), valid at 0800, showed a cloudy area with, among other things, a layer of broken cloud at 3000 feet agl and visibility of 6 sm (Appendix B). Isolated cumulonimbus clouds with tops of up to 14 000 feet created a risk of light rain and fog, which could reduce visibility to 5 sm and result in ceilings at 800 feet agl. However, a radar image of the flight area did not show echoes that might indicate the presence of cumulonimbus clouds. No AIRMET[12] or SIGMET[13] was issued for the flight area on the day of the accident.

The aviation routine weather report (METAR) at 0900 for the Sept-Îles Airport, situated about 7 nm southeast of the Héli-Excel base was as follows: winds 100° True (T) at 11 knots, gusting to 17 knots; visibility 4 sm; a ceiling of 200 feet; and temperature of 15°C. At 1000, visibility increased to 10 sm and the ceiling to 300 feet. At 1100, visibility was 8 sm and the ceiling was still at 300 feet.

11 Transport Canada, TP14371, CAR 3.5 Weight and Balance Form

12 AIRMET: Airmen's Meteorological Information

13 SIGMET: Significant Meteorological Information

The weather report for Poste Montagnais obtained before departure was as follows: ceiling of 900 feet agl, visibility of 20 sm and wind 200° magnetic (M) at 10 knots. Other helicopter pilots flying in the valleys of the Moisie and Nipissis rivers reported ceilings below the mountain peaks with adequate VFR visibility.

The flight was conducted in uncontrolled airspace at an altitude below 1000 feet agl according to VFR. Under these conditions, flight visibility must not be less than 1 sm[14] and the aircraft must be operated clear of cloud. When weather conditions are below the VFR weather minima, they are defined as instrument meteorological conditions (IMC).

1.8 Navigation Aids

N/A

1.9 Telecommunications

N/A

1.10 Aerodrome Information

N/A

1.11 Flight Recorder

The helicopter was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR) nor were they required by regulation.

1.12 Wreckage and Impact Information

The tailskid left a straight furrow of about 6 feet before the crater caused by the impact of the helicopter. The crater rim had an angle of about 45° and was about 3 feet deep. The tail boom was severed; the 2 skids and the carrying basket remained in the crater (Figure 4). The main rotor crashed through the front of the cabin and severed the instrument panel. The helicopter then bounded and came to rest on its back 90 feet away.

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14 CAR 602.115, Minimum Visual Meteorological Conditions for VFR Flight in Uncontrolled Airspace

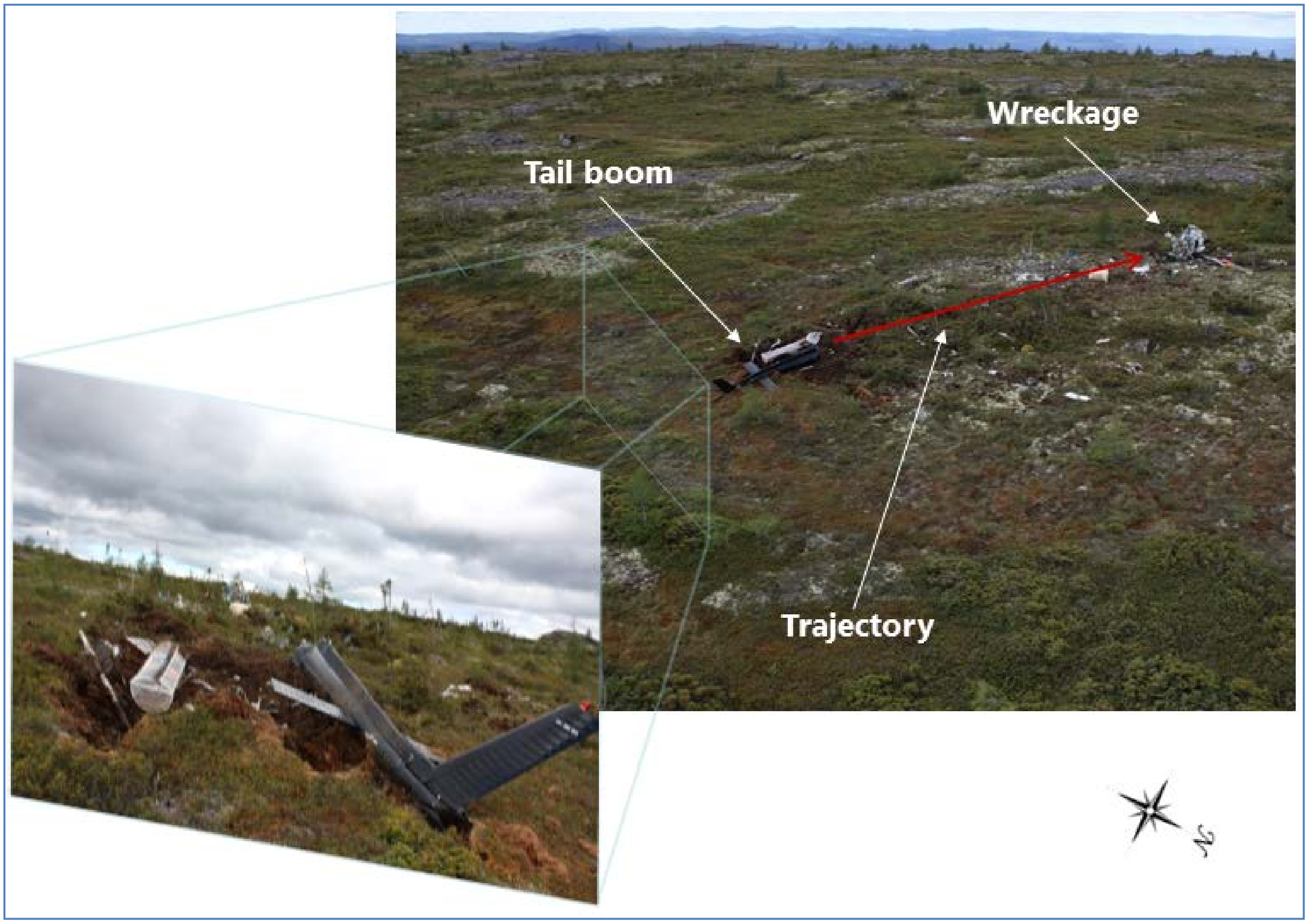

Figure 4. Photographs of accident site showing helicopter wreckage and breakup trajectory

1.13 Medical and Pathological Information

A review of the pilot's medical records obtained from TC showed no medical condition or disease that might have affected the pilot's performance.

1.14 Fire

There was no fire on impact.

1.15 Survival Aspects

N/A

1.16 Tests and Research

N/A

1.17 Organizational and Management Information

1.17.1 Company Information

Héli-Excel Inc. holds a valid operating certificate and its base is located about 7 nm northwest of Sept-Îles. At the time of the accident, Héli-Excel was operating a fleet of 20 helicopters (Bell 205, Bell 206, Bell 206L, Bell 214B-1, Eurocopter AS350-B, BA, B2, D and F-AS355). The aircraft are operated under Subparts 2 and 3 of Part VII of the CARs. The flight in question was operated under Subpart 3 - Air Taxi Operation.

Héli-Excel holds Operations Specification 005, which authorizes day VFR flight in uncontrolled airspace with flight visibility of less than 1 sm, i.e., up to ½ sm. However, CARs Standard 723.28 must be respected. More specifically, the pilot must have accumulated 500 flight hours as a helicopter pilot-in-command. The company is subject to a Type "D" operational control system whereby operational control is delegated to the pilot-in-command of a flight by the operations manager who retains responsibility for the day-to-day conduct of flight operations.[15]

The operations manager must ensure that flight operations are executed in accordance with CARs standards relating to commercial air services and the policies and procedures in the company operations manual (COM).[16] In addition, day VFR flights from the base of operations must be authorized by the operations manager or chief pilot.

The pilot-in-command (PIC) is responsible for the operation and safety of the aircraft under his command and for the safety of all occupants on board. Therefore, the PIC makes the final decisions regarding use of the aircraft while in charge.[17] PIC is required to perform the duties in compliance with the CARs.

According to the COM, the PIC is responsible for ensuring that take-off and landing weight does not exceed the limits specified in the flight manual of the certified helicopter. However, the weight and balance do not need to be computed for each flight if a loading pattern is used.[18]

Loading patterns in the form of weight charts can be used to quickly determine the maximum allowable baggage weight based on the amount of fuel and number of passengers on board (Appendix C). Héli-Excel does not record the weight transported on its helicopters nor is it required to do so by regulation.

1.17.2 Regulatory Oversight

Transport Canada (TC) develops and administers policies and regulations for the civil aviation system. Its aviation safety program aims to control the risks at acceptable levels through a systemic approach. The introduction of safety management systems (SMS) for the aviation industry is fundamentally changing the way TC approaches its surveillance responsibilities.

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15 CARs Part VII, Standard 723.16 Operational Control System

16 COM 2.2.3 Operations Manager – Responsibilities (3)(*b*)

17 COM 2.2.7 Pilot-In-Command – Responsibilities (10)

18 COM 4.6.3 Weight and Balance Management – Loading (4) (*a-d*).

Traditional surveillance methods have been replaced with assessments and program validation inspections (PVIs) [19] as the primary surveillance tools. Assessments and PVIs are used to measure operational effectiveness and CAR compliance, but the PVI is a routine surveillance method.[20] Transport Canada conducts additional inspections and interventions as needed and based on available resources, including occasional field audits of all the aircraft present at the base concerned. Between 2005 and 2010, TC conducted 14 field audits in Quebec, 2 of them in Sept-Îles. However, none of these dealt specifically with overloaded helicopter flights.

According to the TSB Watchlist published in 2012, TC does not always effectively control carriers in the process of developing an SMS, and some are not even required to adopt such a system.

Implemented properly, SMS allow aviation companies to take care of identifying hazards, managing risks, and developing and following effective safety processes. Canada's large commercial carriers have been required to have an SMS since 2005. However, for smaller operators, such as those that do aerial work or provide air taxi or commuter services, implementation has been delayed to provide additional time to refine procedures, guidance material, and training. Yet this group accounted for 91% of commercial aircraft accidents and 93% of commercial fatalities from 2002 to 2011. Transport Canada indicates that SMS will be implemented in all regulated civil aviation organizations by 2015.

The TSB is calling for TC to effectively monitor the integration of SMS practices into day-to-day operations. Moreover, SMS practices need to be adopted by all air carriers.

Héli-Excel has an SMS. However, because it is not required by the CARs, its effectiveness has not been verified by TC.

Héli-Excel's PVI, conducted in February 2010, found no non-compliance with any operational control aspect as it met all the measurement criteria. The company even earned a high score because it met 5 of the 8 criteria required for a perfect score.

1.17.3 Surveillance by Frequent Users of Helicopter Services

In general, clients that use commercial helicopter services rely on the operator and the pilot to ensure flight safety. However, the employer is responsible for employee health and safety and must take reasonable precautions to ensure the workplace is safe. Consequently, some frequent users of helicopter services, including Hydro-Québec, have chosen to implement their own surveillance measures and criteria over and above CARs standards.

1.17.3.1 Société de protection des forêts contre le feu

The Société de protection des forêts contre le feu (SOPFEU) is a private non-profit organization whose mission is the prevention, detection, and suppression of forest fires. SOPFEU evaluates each type of helicopter before use to ascertain its operational viability and compliance with the CARs. Crew equipment is classified by mission type and weighed, as are crew members, so that

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19 A process comprised of a documentation review and an on-site review of one or more components of an SMS or other regulated areas of a certificate holder

20 Transport Canada, Staff Instruction (SI) No. SUR-001, Subsection 13.1, page 40

the total weight is known before boarding and loading. Any additional equipment is weighed at the base before deployment.

The pilot determines how much fuel is required for the mission and, based on the maximum allowable take-off weight, calculates the maximum allowable load. The load limit is then used to determine the number of people, with their equipment, that can be transported.

SOPFEU provides its pilots and crew with annual training on its procedures. Lastly, the organization has a confidential reporting system so that users can report incidents or concerns about SOPFEU operations.

1.17.3.2 Ontario Ministry of Natural Resources

The Ontario Ministry of Natural Resources aviation services meets the needs of the Ministry for specialized aviation services and provides or arranges non-scheduled air transportation for the Ontario Government. The Ministry practice is to weigh equipment and classify equipment kits by type of work to be performed.

The Ministry uses a form to calculate the helicopter's take-off weight. Actual passenger weights are used with the preset equipment kit weights and entered on the form before the scheduled flight or series of flights. The form is then signed by the team leader and the pilot attesting that the maximum allowable take-off weight has been respected.

The Ministry's aviation service provides training for new pilots assigned to Ministry operations, and annual refresher training is provided to employees traveling by helicopter. The Ministry's policies are aimed at ensuring the respect of weight and balance limits.

From time to time, the toolkits are weighed in the field to ensure the preset maximum weight is being respected. Lastly, the Ministry's SMS incorporates a mechanism that allows users to report incidents, experiences they found unsafe, or situations that could compromise flight safety.

1.17.3.3 Hydro-Québec

Hydro-Québec's Air Transport Unit uses the services of several operators in Quebec to perform aerial work by helicopter. With annual flight time averaging upwards of 15 000 hours, Hydro-Québec is the helicopter services industry's biggest customer in Quebec. In 1992, following a series of accidents, Hydro-Québec set up a qualification and technical audit program to evaluate the helicopter companies it uses and ensure they maintain their aircraft in accordance with the CARs.

In 2005, Hydro-Québec developed a technical assessment method to evaluate its carriers. This method was implemented in collaboration with the École nationale d'aérotechnique (ENA), which conducts a quality audit every 18 months on average and produces a report. Hydro-Québec then completes an assessment based on the carrier's past performance and compliance with contractual requirements. The result is expressed as a percentage, which is then used to assign a qualification level to the carrier. [21] Hydro-Québec indicates the minimum qualification level in calls for tender for helicopter services.

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21 The qualification levels range from R1 to R5, R1 being the highest.

Héli-Excel underwent a qualification audit on 24 February 2010, obtaining an R2 rating (second highest level).

When a Hydro-Québec work group requires helicopter services, it sends its requirements to the Air Transport Unit, which forwards the charter request to qualified carriers based on a price list submitted during the tender process. Flight logistics are then coordinated between the requester and the carrier. The carriers contacted have the option of refusing the request.

Hydro-Québec requires pilots to have logged a minimum of 800 hours of total flying time, including 100 hours on the type of helicopter chartered. The total time is reduced to 250 hours if the pilot has completed the training program offered by the Association québécoise du transport aérien (AQTA). The pilot had not completed this training.

Hydro-Québec distributes an information sheet to travelling employees, recapping safety instructions for helicopter travel. [22]

1.18 Additional Information

1.18.1 VFR into IMC

In 1998, TC released a report prepared by the Safety of Air Taxi Operations Task Force (SATOPS),[23] which examined, among other things, VFR flight when visibility is lower than the minimum prescribed by regulation. Among the recommendations to reduce the number of accidents, the Task Force called on TC to increase its surveillance and provide greater oversight. In response, TC set a goal to cut the average 5-year air taxi accident rate by half by 2005.

In September 2005, industry stakeholders attending the International Helicopter Safety Symposium (IHSS) in Montréal recognized that the accident rate had not improved in the previous 20 years. In response, the International Helicopter Safety Team (IHST) was created with the aim of reducing helicopter accident rates by 80% in 10 years. The IHST then mandated the Joint Helicopter Safety Analysis Team (JHSAT) to analyze helicopter accident data and to offer recommendations for reducing the accident rate. The JHSAT report, published in 2007, contained 127 safety recommendations, some of which specifically addressed VFR flight in IMC. However, in 2012, these recommendations had still not been incorporated into Canadian helicopter operations.

In 2007, TC published another study[24] on VFR flights in adverse weather conditions that raises customer pressure as an aggravating factor in operational risk.

Meanwhile, the Australian Transport Safety Bureau published a study[25] in 2007 showing that 75.6% of accidents associated with VFR flight in IMC resulted in loss of life. As well, in the U.S.,

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22 Hydro-Québec, *Consignes de sécurité pour les passagers d'hélicoptères*

23 Transport Canada, SATOPS – Final Report, TP 13158, 1998

24 Transport Canada, Safety Study on Risk Profiling the Air Taxi Sector in Canada, http://www.tc.gc.ca/eng/civilaviation/regserv/safetyintelligence-airtaxistudy-menu-496.htm, accessed on 18 March 2013.

in 2008, 88% of such accidents resulted in fatalities, compared to 17% for other types of accidents.

TSB data shows similar results: 80% of accidents associated with loss of visual reference result in fatalities, although they account for just 15% of all accidents. TSB aviation investigation reports[26] have pointed out the risks surrounding VFR flight in IMC more than once, specifically citing VFR flight in adverse weather conditions in their findings as causes and contributing factors.

A TSB Aviation Study (90-SP002) suggests that, more recently, licensed helicopter pilots who have acquired basic instrument flying experience to obtain their licence will find that their instrument flying skills will deteriorate if not practised. Therefore, the benefit of one-time exposure to advanced flying skills acquired during licence training and necessary for a safe recovery from whiteout conditions may be lost. There is no requirement to undergo refresher training in basic instrument flying as a condition of licence-revalidation. An evaluation of a pilot's basic instrument flying skills during the Pilot Proficiency Check (PPC or PCC) would ensure that commercially-employed helicopter pilots, regardless of when they obtained their licence, would regularly demonstrate proficiency in skills necessary for coping with the major cause of VFR helicopter accidents in adverse weather. Therefore, the Board recommends that:

> The Department of Transport require verification of proficiency in basic instrument flying skills for commercially-employed helicopter pilots during annual pilot proficiency flight checks.
>
> Recommendation A90-81

In order to follow this recommendation, helicopters must be equipped with an attitude indicator and a directional gyro. C-GIYR was not so equipped nor was it required by regulation to be so for VFR flights. Transport Canada maintains that inadvertent VFR flights in IMC make up only a small percentage of accidents due to VFR flights in IMC.

As it stands, the risks associated with VFR flights in adverse weather conditions are still significant and TC has not indicated that it plans to take steps to ensure commercial helicopter pilots who are not qualified in instrument flying, as described in Recommendation A90-81, maintain their proficiency in this regard. Consequently, the reassessment of TC's response remained unsatisfactory in 2012.

In 2010, the European Helicopter Safety Team (EHEST) conducted an analysis of helicopter accidents in Europe between 2000 and 2005[27] and formulated intervention recommendations that could potentially prevent similar accident factors from reoccurring. A number of them pertain to initial and refresher training on inadvertent entry into IMC and recovery from unusual attitude by sole reference to instruments. The EHEST also recommended improving audits, inspections, and regulatory oversight, with the ability to enforce more sanctions against those who do not follow the rules.

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[25] Australian Transportation Safety Bureau (ATSB) Aviation Research and Analysis Report – B2007/0063 – An overview of spatial disorientation as a factor in aviation accidents and incidents

[26] TSB aviation investigation reports A08P0353, A09Q0111, A10Q0111, and A10A0056

[27] EHEST, "Analysis of 2000–2005 European Helicopter Accidents"(Köln, Germany: European Aviation Safety Agency, 2010).

1.18.2 *Risks Associated with Loss of Visual References*

Pilots operating in marginal weather conditions[28] fly at low altitude, close to the terrain so as to maintain visual contact with the ground. Under these conditions, they are at great risk of inadvertently entering IMC where visual references may no longer be sufficient to retain control of the aircraft.

At low speed, the AS350, as most helicopters would, found itself in an inherently unstable situation that increased as its speed decreased. Because helicopter pilots usually reduce their speed when visibility is reduced, the risk of losing control of the aircraft increases.

1.18.3 *Spatial Disorientation*

The visual system is by far the most important of the 3 sensory systems, providing 80% of the raw information. Therefore, when visual cues are lost, 80% of the orientation information is lost, leaving only 20%, divided equally between the vestibular[29] and proprioceptive[30] systems, both less accurate and prone to illusions and interpretation errors.

Gravitational force acts on the otolith organ of the vestibular system. The change of force exerted during flight can distort the interpretation of the gravitational force, and therefore vertical posture. For example, a somatogravic illusion is a powerful sensation of pitch during acceleration. In the absence of visual cues, the acceleration is perceived by the brain as a tilt backward. Conversely, deceleration is perceived as a tilt forward.

The proprioceptive system helps a person keep track of and adjust different parts of his body in relation to the pull of gravity. Although proprioception enables the pilot to stabilize his body in the cockpit and gives valuable clues to changing directions and attitudes in visual flying conditions, in instrument conditions "flying by the seat of the pants" can rapidly become lethal as centripetal and centrifugal forces compete with gravity and proprioception may be confused.

Spatial disorientation occurs when the pilot fails to correctly sense the position, motion, or attitude of his aircraft or himself in relation to a fixed coordinate system defined by the surface of the Earth and the gravitational vertical.[31] In other words, when the pilot is disoriented, he is unable to locate himself in space and therefore cannot control the aircraft for an extended period.

It is important to emphasize that all pilots can experience spatial disorientation and that if a pilot flies long enough, he will eventually encounter situations where he will experience spatial disorientation. That said, the result is not always loss of aircraft control. There are several preventive steps to mitigate the risk of spatial disorientation or of such an event leading to an accident, and most of them can be taken before flight is undertaken.[32]

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28 Weather in which the pilot is on the verge of losing visual reference with the ground

29 Inner ear system used to maintain balance

30 System that allows us to be aware of our body position

31 Benson, A. "Spatial disorientation – general aspects", in J. Ernsting & P. King (Eds.), *Aviation Medicine* (London: Butterworths & Co.Ltd., 1988), pp. 277–296.

32 *An Overview of Spatial Disorientation as a Factor in Aviation Accidents and Incidents*, Australian Transportation Safety Bureau (ATSB) Aviation Research and Analysis Report – B2007/0063

In short, fatigue, stress, a cold, alcohol, and certain medications can increase the risk of spatial disorientation. However, awareness of the potential of disorientation during flight is a key step to preventing loss of control in flight.

In one experiment, private pilots untrained in instrument flying were placed in a simulator and taken from visual flying conditions into dense cloud where they were required to make a 180° turn. All crashed within 178 seconds.[33]

1.18.4 Pilot Decision-making

Pilot decision-making (PDM) is a crucial aspect of flight safety. PDM can be defined as a 4-step loop: gathering information, processing information, making a decision, and acting on that decision.[34] The assessment of available options includes a subjective assessment of the risk based on experience and knowledge.

Many factors can affect the pilot's decision, including situational awareness, experience, training, skills, expectations, goals and objectives, organizational and social pressures, time pressure, and various contextual factors. A successful flight under similar conditions can increase risk tolerance and encourage the pilot to continue the flight in marginal conditions.

According to the SATOPS report, client pressure is a factor that may prompt pilots to fly in conditions that they would otherwise regard as dangerous. These pressures can be overt, such as specific requests and threats to use other operators willing to take more risks, or covert, when companies and pilots seek to satisfy their customers by demonstrating their reliability.

There are a number of tools that can be used to assess risk, includingchecklists for indentifying the risks associated with a specific flight, which can guide the pilot in his pre-flight preparations. Tools such as the EHEST's Pre-departure Risk Assessment Check List show how situations that seem simple by themselves, can, when combined with others, raise the overall flight risk.

1.18.5 Cognitive Dissonance

Beyond the factors acting on the decision-making itself, influences after the decision is made can distort interpretation of the results. When a pilot must choose between two options, such as continuing a flight in marginal conditions or initiating a diversion, a state of tension or dissonance is created. Once the decision to continue is made, the pilot will attempt to reduce this dissonance by emphasizing the positive aspects of the decision (to continue) and amplifying the negative attributes of the rejected option (the diversion). This automatic, unconscious process rules out alternatives and is also called post-decision distortion.

The theory of cognitive dissonance provides a compelling decision-making model to explain why a VFR flight would continue in adverse weather conditions. According to this theory, there is a tendency to continue with the chosen course of action after the decision is made. Moreover, the influence of dissonance is cumulative. Each time a new decision is made to continue instead

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33 Transport Canada, TP 13312 – Handbook for Civil Aviation Examiners, Section 2, Orientation and Disorientation

34 Transport Canada, Pilot Decision Making — PDM, TP 13897

of divert, the gap between the alternatives (post-decision distortion) grows wider, prompting the pilot to make increasingly risky decisions.

To reduce the influence of dissonance, it is important to make as many decisions as possible ahead of time, focus on the information available at the time of the decision, and separate new decisions from previous ones.

1.18.6 Development of Adaptations and Reduced Safety Margins

Time and resource pressures can result in pilots making adaptations to get the job done. While procedures and regulations are prescribed in order to set limits for safe operations, pilots may stretch the limits in order to become more productive. This leads to adaptations of procedures and a shift beyond the prescribed boundaries toward unsafe practices.[35]

When work methods are adapted, the harmful consequences are not usually immediately visible because procedural violations do not immediately lead to an accident, which is why the adaptation continues.

The communication of successful adaptations, such as flying overloaded, among crew members will tend to lead to the spread of these adaptations throughout an organization unless adequate supervision is applied.

In addition, performance requirements impose constraints that may lead pilots to work outside the rules to accomplish the task.[36] Without regular supervision, education, and enforcement of the expected limits, individuals are likely to continue to adapt procedures until the actual unsafe boundary is found through the occurrence of a minor or major accident.

1.18.7 Passengers

The U.S. Federal Aviation Administration (FAA) has recognized that the regulations governing pilots and operators are insufficient to reduce accidents. The FAA believes that passengers also have a role to play in flight safety during adverse weather conditions. It therefore set up the Circle of Safety Program in Alaska to inform travelers about, among other things, the weather conditions required and minimum altitudes for VFR flight.

1.19 Useful or Effective Investigation Techniques

N/A

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35 J. Rasmussen, “Risk management in a dynamic society: a modeling problem,” *Safety Science*, p. 197, 27(2–3), 183-213.

36 Dekker, *The Field Guide to Understanding Human Error*, Ashgate, 2006.

2.0 Analysis

2.1 General

Examination of the wreckage and components revealed no evidence of any structural failure, flight control malfunction, or loss of power that could have caused the accident.

The possibility of hydraulic failure or a malfunction of the flight controls was eliminated. According to the analysis performed by the TSB Laboratory, engine torque was at the maximum allowable limit at the time of impact with the ground, indicating that the pilot fully applied the collective. Hydraulic failure or a flight control malfunction would have caused an uncoordinated shift and a sharp yaw to the left when the collective was applied. However, the groove left on the ground by the tailskid and the breakup trajectory were rectilinear.

The helicopter took off overloaded in marginal weather conditions and 50 minutes later struck the top of a plateau at a sharp angle, 22 nm from the departure point. The analysis will therefore focus on the circumstances surrounding the flight, the pilot's decision, the VFR flight into IMC, and surveillance of helicopter operations.

2.2 Operational Circumstances

2.2.1 General

Hydro-Québec is the largest user of helicopter services in Quebec and being excluded from the utility's calls for tender can have serious financial consequences for a carrier. It is therefore reasonable to assume that when carriers receive a charter request from Hydro-Québec, they do whatever they can to provide the requested service.

Based on the AS350-B2 weight chart, it would have been impossible to fulfill Hydro-Québec's initial request to transport 4 passengers and 300 pounds of baggage on the AS350-B2 without exceeding the maximum take-off weight of 4960 pounds with the usual fuel load.

Since an AS350-B2 was not available, Hydro-Québec agreed to an AS350-BA. However, based on the weight chart of C-GIYR (AS350-BA), with the fuel tank 60% full, 4 passengers and none of the 300 pounds of baggage, the aircraft would have exceeded the maximum take-off weight of 4630. Therefore, it was impossible to meet Hydro-Québec's charter request and respect the CARs even if the 300 pounds of baggage were transported another way

2.2.2 Client Pressures

Hydro-Québec's charter request seems inconsistent with the safety measures in place, as neither the first nor the second request could be carried out within the maximum allowable take-off weight.

In the absence of a verification mechanism to ensure that the request is consistent with the load limit of the chartered helicopter, it is up to the carrier, regardless of the competitive environment in which it operates, to limit this major client's demands in order to respect the CARs.

2.2.3 *Carrier Pressures*

The company accepted the charter request, which required an overloaded take-off, and the pilot assigned to the flight did not meet Hydro-Québec's experience criteria. It is likely that the inexperienced pilot felt the operational pressures surrounding this flight. These pressures are known to influence pilot decision making negatively.

2.2.4 *Passenger Pressures*

The morning of the flight, the passengers arrived with 761 pounds of baggage instead of the expected 300 pounds. The passengers were probably not aware that the charter request indicated 300 pounds or of the agreement to reduce this load because an AS350-BA would be used. Although the scale inside the hangar was not used, the pilot could tell there was too much baggage.

All the AS350 models are similar in appearance despite having different maximum allowable take-off weights. Passengers can therefore easily confuse the models and be surprised to see the pilot limit the baggage weight when they had taken similar flights in the past with all their tools.

Given that baggage weight is estimated, it is difficult for a pilot to demonstrate quantitatively that passengers have more baggage than initially indicated in the charter request or even that the weight of the aircraft is at the maximum permitted at take-off.

Because the flight could not take place in a straight line above the terrain, the pilot had planned for a 75% fuel load, which was reduced to 60% when loading, i.e., about 600 pounds or 2 hours'flight time. It is reasonable to conclude that the pilot was facing pressure from the passengers, who wanted to keep their tools. Although it was agreed with the passengers to send 200 pounds of baggage by air, the fact remains that 561 pounds of baggage was loaded onto C-GIYR, which took off 476 pounds over the maximum allowable take-off weight. Passenger pressure is what probably caused the pilot to reduce the fuel load, accept the bulk of the baggage, and take off with what was clearly too much weight.

The pilot did not follow established procedures to meet operational requirements, and this adaptation of procedures beyond established limits confirms the need for limits to be routinely supervised and monitored—otherwise, the situation can go on for years without the pilot realizing how close he actually is to the limits of safety.

From an organizational point of view, it was unrealistic to expect a young pilot to tell the passengers at the last minute, i.e., when boarding, that they could not bring the tools they needed to do their jobs without provoking a reaction from them.

When the terms of transport are clearly stated by the client and the baggage limit is determined in advance, the passengers are not caught off guard when boarding. Some frequent users establish load limits in advance and make the passengers responsible for controlling the load transported. One client even requires the passenger foreman and pilot to sign the form used to calculate the helicopter take-off weight. In such conditions, flight safety does not depend solely on the pilot's ability to withstand user pressure.

The nature of helicopter operations is such that it is not always possible or necessary to weigh everything in order to accurately calculate the helicopter take-off weight before each flight, for example, for multiple, short trips with a slung load, or with the same workers and their baggage or tools. The CARs provide some flexibility in the use of preset weights and configurations, provided that the pilot respects the take-off weight limits on the first take-off in a series of flights, for example, or at the start of a contract with the same workers and their tools.

Because the load was not accurately calculated, the take-off weight was not computed and consequently no data were recorded in the aircraft's logbook. It was therefore not possible to look at C-GYIR's past loads or take-off weights, nor is this required by regulation.

Formally documenting the load and take-off weight makes the pilot accountable, provides the carrier with a quantitative measurement to show the client, and minimizes the possibility of conflict between pilot and passengers. Such documentation would allow TC to exercise regulatory oversight of loads transported during helicopter operations.

2.3 *The Flight*

The pilot took off and followed the power lines northeast at low speed due to reduced visibility.

When he veered northeast towards the Moisie River, his speed increased to normal cruising speed, indicating there was better visibility for this low-level flight in the valley. Once in the Moisie River valley, a flight can usually follow the rail tracks north to Poste Montagnais.

At the junction of the Nipissis River, the pilot continued over the Moisie River instead of maintaining the flight path and following the railway tracks north (Figure 5, 1127). It was not possible to determine why the pilot made this decision.

Eight minutes later, the pilot turned right, leaving the Moisie River and taking a valley towards Poste Montagnais (Figure 5, 1135). However, he made a half-turn at the end of that valley (Figure 5, 1143), going back to the Moisie River. The reduction in speed before the half-turn indicates that visibility was reduced at the end of the valley and that the mountain pass, which was over 2000 feet asl, was in the clouds.

While flying south over the Moisie River, he veered left towards the mountains in the east (Figure 5, 1154). At this point, the helicopter had been in flight 43 minutes and had consumed about 215 pounds of fuel, leaving 385 pounds on board, or fuel endurance of 1 hour 17 minutes.

If the pilot had continued in the Moisie River valley until the junction of the Nipissis River before heading to Poste Montagnais, he would have been left with no more than about 60 pounds of fuel, or 13 minutes of flight time on arrival. The low-fuel indicator on the annunciator panel would have gone on at least 7 minutes before arrival; company policy is to immediately set down when this happens. The pilot would then have had to have fuel brought to him by another helicopter.

Because the aircraft was approximately 24 nm from the departure point, it was still possible to return to the Sept-Îles base to refuel and depart again. However, the weather conditions had been marginal at take-off, and the pilot had been unsure that he would make it to Poste Montagnais. There is no evidence that the pilot received a weather update at this time.

A helicopter pilot always has another option, namely to set down in a safe place and wait for the weather to improve. However, none of these 3 options would sit well with passengers, and the pilot would have had to admit to the passengers, his employer, and Hydro-Québec that he was unable to complete the flight assigned to him. As the flight was also monitored by Hydro-Québec, a delay would have raised questions about the history of the flight, increasing the likelihood that Hydro-Québec would realize that the pilot did not have the experience for the flight required under the contract. Consequently, the pilot probably chose to take a shortcut to the east in the hopes of reaching the Nipissis River valley and reducing the flight time to Poste Montagnais.

Although the flight was at low altitude, the pilot maintained normal cruising speed, meaning that visibility was probably adequate when the aircraft was heading eastward.

2.4 *Flight from VMC to IMC*

When the aircraft reached the side of the mountain, the pilot reduced his speed and resumed a southerly trajectory, indicating that the peaks were in the clouds and that he could not clear them. However, he continued to climb up the mountainside and eventually reached the plateau at the top (Figure 5, 1159). The aircraft flew at the top at between 50 and 100 feet agl and at a ground speed of between 20 and 40 knots, presumably because visibility was below the minimum conditions for VFR flight prescribed by the CARs.

The pilot chose to continue the VFR flight into IMC although he was still able to head west to the Moisie River valley. He probably felt that continuing on was the best option. According to the theory of cognitive dissonance, his subsequent decision to continue on in marginal conditions may have distorted how he weighed the choice between continuing the flight and initiating a diversion: the more consideration a

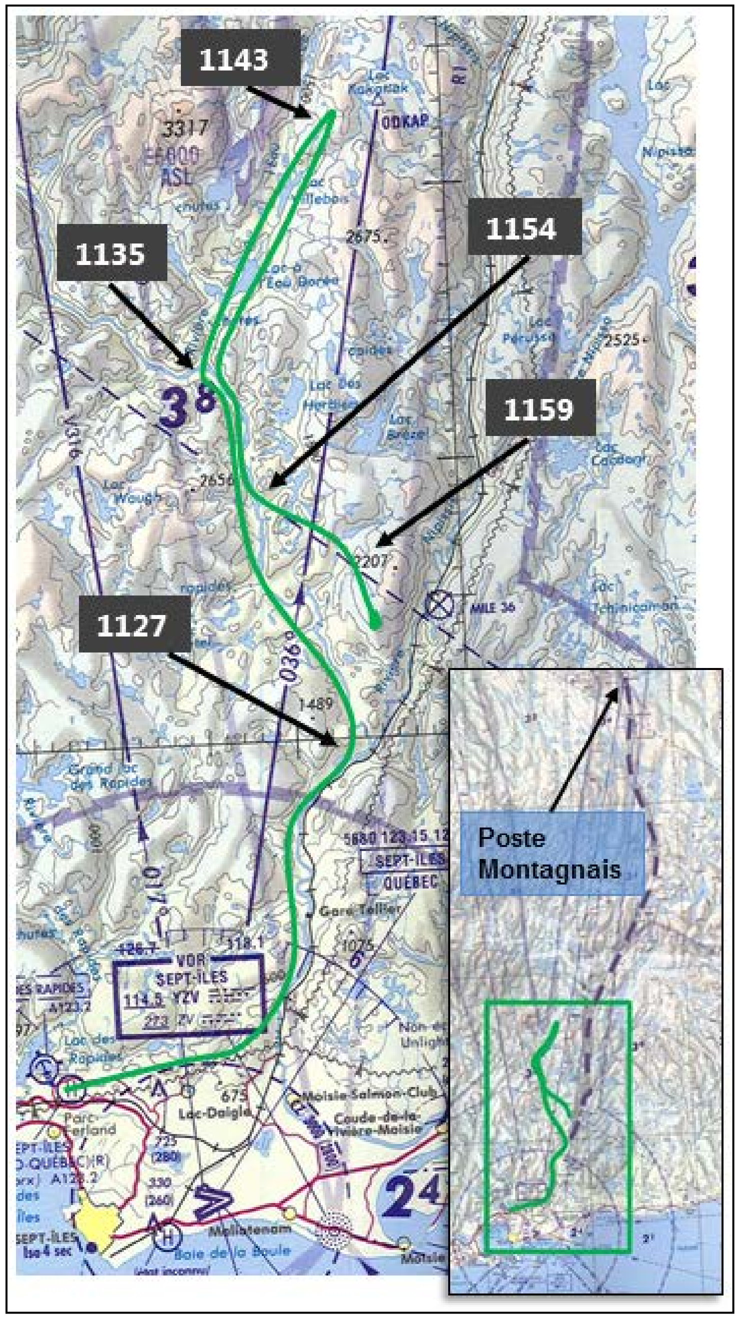


Figure 5. Map showing flight path with time indications

pilot gives to his decision to continue flying, the more likely it is to reinforce his choice, further distorting the situation he is in and increasing the odds that he will make risky decisions.

Other factors may have affected the pilot's decision to continue the VFR flight into adverse weather, including passenger pressure, which can have a negative influence if the passengers are under work-related time constraints. However, it can also positively influence safety decisions if they intervene or challenge the pilot when the flight does not seem to comply with regulations. Challenging the pilot may lead to a safer alternative, such as setting down until the weather improves.

The FAA has acknowledged that regulations alone cannot prevent VFR flights from continuing into IMC. The passenger awareness program introduced in Alaska aims at increasing passenger involvement in flight safety. There is no similar program in Canada.

Another example of awareness is take-off in icing conditions. Passengers are more aware of the risks of taking off with snow or ice on the wings and are now less reluctant to question a take-off in such conditions without de-icing the wings. Simply asking such a question can influence a doubtful pilot to choose the safest option.

In this case, the crucial safety decision to be made during the flight over the plateau in marginal weather was whether or not to continue the flight to reach the Nipissis River valley.

The regulator sets VFR minima that it considers to be the minimum safety limits. Risk increases significantly when pilots insist on following their route in weather conditions that do not favour visual flight. By continuing to fly in adverse weather, the pilot increased the risk of collision with the terrain as well as the risk of losing visual reference with the ground. The helicopter's low speed on the plateau suggests that VFR could not be maintained. At low speeds, the helicopter was in a range of inherent instability that increases the risk of loss of control when visual references are limited.

When C-GIYR reached the southeast end of the plateau where the terrain rapidly descends towards the valley, the aircraft began climbing and its speed decreased. The helicopter climbed about 200 feet, made a half-turn and initiated a descent at an average rate of 4500 feet per minute, striking the surface of the plateau at a steep angle of descent.

Based on the trajectory, it appears that the pilot noticed the visual references loss and quickly tried to slow the aircraft. To quickly slow down a helicopter, a pilot has to increase the attitude by pulling on the cyclic stick while at the same time reducing the collective so as not to initiate a climb. The attitude may have increased just as the plateau gave way to the valley and the pilot lost all visual reference with the ground.

As the visual system provides 80% of orientation information, when the pilot lost visual reference, he retained only the 20% orientation capacity in the vestibular and proprioceptive systems. Both are less accurate and prone to illusions such as somatogravic illusion, which induces a feeling of forward tilt during deceleration. All pilots, regardless of how experienced they are, can suffer the effects of spatial disorientation when exposed to the complex movements of flight.

When the pilot lost visual reference during deceleration, he probably experienced a somatogravic illusion, prompting him to pitch the nose of the aircraft up and initiate a climb.

The helicopter then made a half-turn from a headwind to a tailwind situation. This change of direction resulted in a significant loss of main rotor lift and required application of full power to prevent a descent. The helicopter was probably in the clouds at the time and the pilot did not notice the rapid descent and did not have time to stop the descent when the ground appeared.

The helicopter did not have the necessary instruments nor was the pilot qualified for instrument flight; therefore, the only way to keep control of the aircraft was to maintain eye contact with the ground.

Awareness of spatial disorientation risk is a key element in the prevention of spatial disorientation–related accidents, and most of the measures to reduce such risk involve pre-flight preparation. Experiencing spatial disorientation does not necessarily lead to loss of aircraft control. However, the pilots who participated in the simulator experiment all lost control of the airplane, which is much more stable than a helicopter, in less than 178 seconds. Control of C-GIYR was lost in less than 25 seconds.

Since 1998, many organizations have acknowledged the high risk of fatality in VFR flights into IMC. Their conclusions are similar to those of the TSB, namely that 80% of accidents associated with loss of visual references result in fatalities despite accounting for just 15% of all accidents.

A number of recommendations have been made by the Joint Safety Analysis Team (JSAT) and the EHEST, among others, to increase pilot proficiency in instrument flying, improve equipment, and raise awareness among managers, pilots and passengers of the hazards of flying in conditions of reduced visibility. However, these recommendations have yet to be implemented and this type of accident continues to occur.

TSB Recommendation A90-81 aims at updating instrument flying skills acquired during training to obtain a commercial pilot's license. These skills are designed precisely to help pilots avoid an accident when a VFR flight encounters adverse weather conditions. The fact that most accidents involving VFR flight into IMC are often preceded by a bad decision by the pilot does not diminish the value of maintaining instrument flying skills for dealing with such a situation.

Given the fatality rate for events associated with VFR into adverse weather, the TSB believes that TC's efforts to reduce this type of event are insufficient.

2.5 Surveillance of Helicopter Operations

2.5.1 General

Transport Canada provides regulatory oversight, the carrier ensures that flights are conducted in accordance with the CARs, and the pilot-in-command is responsible for flight safety while respecting CARs limits. In general, the client relies on the carrier and the pilot to ensure flight safety.

2.5.2 Transport Canada

Between 2005 and 2010, TC conducted 2 field audits in Sept-Îles, but these were not specific to overloaded helicopter flights.

Conventional surveillance methods have been replaced by assessments and program validation inspections (PVI), which are used to measure the effectiveness of operational control and CARs compliance. Héli-Excel's last PVI revealed no non-compliance. However, the lack of flight documents indicating the load and take-off weight makes regulatory oversight of overloaded flights impossible.

Regulatory oversight on the ground is rare as there is no document to assess aircraft load when inspections are carried out, nor is there an awareness program to enlist passengers in ensuring CARs compliance. Notwithstanding the frequency of inspections, it is up to the carrier and the pilot to comply with regulations.

2.5.3 The Carrier

Although under the operational control system, the pilot is responsible for flight planning, the operations manager must ensure that flight operations are executed in accordance with the CARs. However, by accepting charters that cannot be carried out in compliance with regulations, the carrier sends a tacit message to the pilot to take off with an overloaded aircraft.

The circumstances surrounding this accident show that the pilot experienced operational pressures that caused him to make compromises that left him with less leeway than he had planned. The unexpected extension of the flight created time pressure that forced the pilot to make choices that would have serious consequences for the passengers, the client, the carrier, and on the perception of his performance as a pilot.

Resources exist to reduce these operational pressures in the form of direct supervision with the use of risk assessment and decision-making tools before take-off. Using these resources to guide the pilot in his decision-making can highlight individual flight-related factors (threats), which can add up and place the flight at a high risk of accident.

With little support from the company, it seems that the safety of the flight rested on the pilot's own ability to resist the operational pressures with which he was confronted.

When inexperienced pilots face operational pressures alone without any support from the company, they can be influenced to make decisions that will place them and their passengers at risk.

From an organizational perspective, it does not make sense to expend so much effort to satisfy the CARs' numerous operational requirements, Hydro-Québec's audits, and contractual stipulations, and then rely on a young inexperienced pilot to ensure flight safety.

Since the CARs do not require Héli-Excel to have an SMS, it is not reasonable to measure the effectiveness of the company's SMS against the standard used by Canada's large commercial carriers.

However, when an SMS is well established and used, carriers can themselves determine the hazards in order to manage the risks. This process incorporates a system that allows all the parties involved in flight operations to report incidents or dangerous situations as well as safety concerns.

It is possible that a well-established SMS will be able to detect and analyze the discrepancy between the effort to meet client needs safely and the reality of passengers' operational requirements, and find another way to manage their expectations.

2.5.4 Hydro-Québec

Although it has no responsibility vis-à-vis the CARs, the employer does have an obligation to ensure safety in the workplace for its employees. Hydro-Québec makes it a point to find technically qualified carriers and experienced pilots, and to monitor the progress of its flights. However, it does not verify whether the maximum allowable take-off weight and VFR weather minima are respected.

Hydro-Québec, and by extension its travelling employees, exerts considerable influence on the carrier and the pilot. Hydro-Québec may have persuaded the carrier to accept the charter and the pilot to agree to load the passengers' very heavy baggage. Finally, this influence could also be why the pilot continued the VFR flight into IMC despite safer albeit less convenient alternatives for the client.

In the absence of regulatory oversight on the ground, the other stakeholders (air carrier, pilot, client, and passengers) must all actively work to create and maintain a safety culture, which at the very least aims at ensuring compliance with the CARs, even when no-one is looking.

3.0 Findings

3.1 Findings as to Causes and Contributing Factors

1. For unknown reasons, the pilot did not take the fork in the Nipissis River but eventually had to turn back because of the clouds covering the terrain. This extension of the flight reduced the amount of fuel available to reach the destination.

2. The pilot had reduced the fuel load to accommodate the large amount of baggage, thus decreasing flight endurance in the event of unforeseen circumstances. This decreased endurance is what probably prompted the pilot to take a shortcut towards the mountains in order to return to the original flight route.

3. The pilot continued the flight in conditions that were below visual flight rules (VFR) weather minima specified in the *Canadian Aviation Regulations* (CARs), thus increasing the risk of losing visual reference with the ground.

4. While the aircraft was flying in marginal weather conditions above the plateau, the pilot lost visual contact with the ground and then control of the aircraft, causing it to crash into the ground.

3.2 Findings as to Risk

1. When a large client charters a helicopter for a flight that cannot be carried out in compliance with the CARs, and the carrier agrees, the pilot is subject to tacit pressure to take off with an overloaded aircraft.

2. When the passengers of a large client show up with excess baggage, they exert implicit pressure that could lead the carrier and pilot to allow an overloaded flight.

3. When baggage is not weighed, the take-off weight cannot be accurately calculated, and the helicopter may take off with weight in excess of the maximum allowable, thus increasing the risk of an accident due to overload.

4. When inexperienced pilots face operational pressures alone without support from the company, they can be influenced to make decisions that place them and their passengers at risk.

5. Transport Canada exercises little regulatory oversight of helicopter operations on the ground, and load details are not recorded in the logbooks. Conseuqently, there is no way of knowing whether a flight is overloaded on take-off.

6. Although the emergency locator transmitter (ELT) emitted a signal, it was not picked up by the COSPAS-SARSAT system because the antenna was severed. This may have delayed search and rescue efforts, affecting the survival of the occupants.

7. Commercial helicopter pilots do not routinely practise instrument flying or regaining control of a helicopter with an unusual attitude solely with reference to the flight

instruments. They are therefore at greater risk of losing aircraft control if they lose visual contact with the ground.

3.3 Other Finding

1. Programs for passenger awareness of flight conditions permitted by regulation may encourage passengers to question the pilot's decision to continue a VFR flight below the weather limits prescribed by regulation.

4.0 Safety Action

4.1 Action Taken

4.1.1 Action Taken by Héli-Excel

Héli-Excel has taken the following remedial action since the accident on 17 August 2010.

- The maintenance manager, avionics technician, and a specialized firm are working on a Limited Supplemental Type Certificate (LSTC) to equip the entire fleet with digital flight instruments (Horizon and DG), which are more reliable than mechanical ones.
- Additional management staff has been hired to increase pilot supervision.
- A safety system manager position that does not report to the operations manager has been created.
- Initial training of newly certified pilots is now much more extensive and involves 20 to 25 hours of dual instrument instruction.
- Training on the ground and in flight has been introduced to reduce the risks of flying in bad weather.
- An 8-hour decision-making and CFIT avoidance course has been developed and is being delivered by an experienced pilot.
- Héli-Excel is building an outdoor scale on the tarmac to check the real weight of goods loaded.
- Every aircraft is now equipped with a portable hanging scale.
- Personal scales are also available to pilots who ask for them.
- Repeated requests have been made to the Société de protection des forêts contre le feu (SOPFEU) and to Hydro-Québec to install permanent scales at their bases of operations.
- When accepting a charter request, Héli-Excel now tries to ascertain the client's real needs in order to recommend the appropriate helicopter.

- Various weight and balance calculation tools are now available to pilots, e.g., an Excel spreadsheet and reimbursement for the purchase of iBal and Appventive (weight and balance apps).

- Surprise audits are conducted to ensure pilots complete and respect the weight and balance forms and fly according to company standards.

4.1.2 Action Taken by Hydro-Québec

- 25 November 2010: at the annual meeting of the Association québécoise du transport aérien (AQTA), Hydro-Québec presented its employee awareness program, "La sécurité aérienne passe par le respect de certaines limites" [Air safety comes with compliance], and announced changes to its contractual requirements in order to secure the commitment of its helicopter providers to address concerns raised by incidents in 2010:

    - Flight in bad weather (VFR limit)
    - Take-off with an overloaded aircraft (weight limit in the aircraft manual)
    - Flight within the height–velocity curve (altitude–speed)
    - Flight within less than 11 metres of power lines and communication towers.

- 10 November 2010: Hydro-Québec increased surveillance and validation of hours of flying experience as well as the training program for helicopter pilots used in Hydro-Québec charter flights.
- January 2011: Hydro-Québec added an air safety component (respect of operational limits) to its helicopter provider evaluations.
- April 2011: Hydro-Québec launched its employee awareness program. More than 20 sessions have been held so far for key user groups.
- January 2012: Hydro-Québec added unannounced audits to its helicopter provider evaluations, particularly at job sites serviced by charters to ensure, among other things, that loads do not exceed aircraft weight limits. Hydro-Québec now also requires its providers to implement a safety management system (SMS).
- June 2012: Hydro-Québec launched its field surveillance program with surprise audits of charter flights, focussing on specific issues of concern.
- Certain clauses in contracts have been amended to ensure that weight and balance forms are completed for all flights conducted for Hydro-Québec. This aspect is checked during the unannounced audits.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 23 January 2013. It was officially released on 26 March 2013.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. 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.

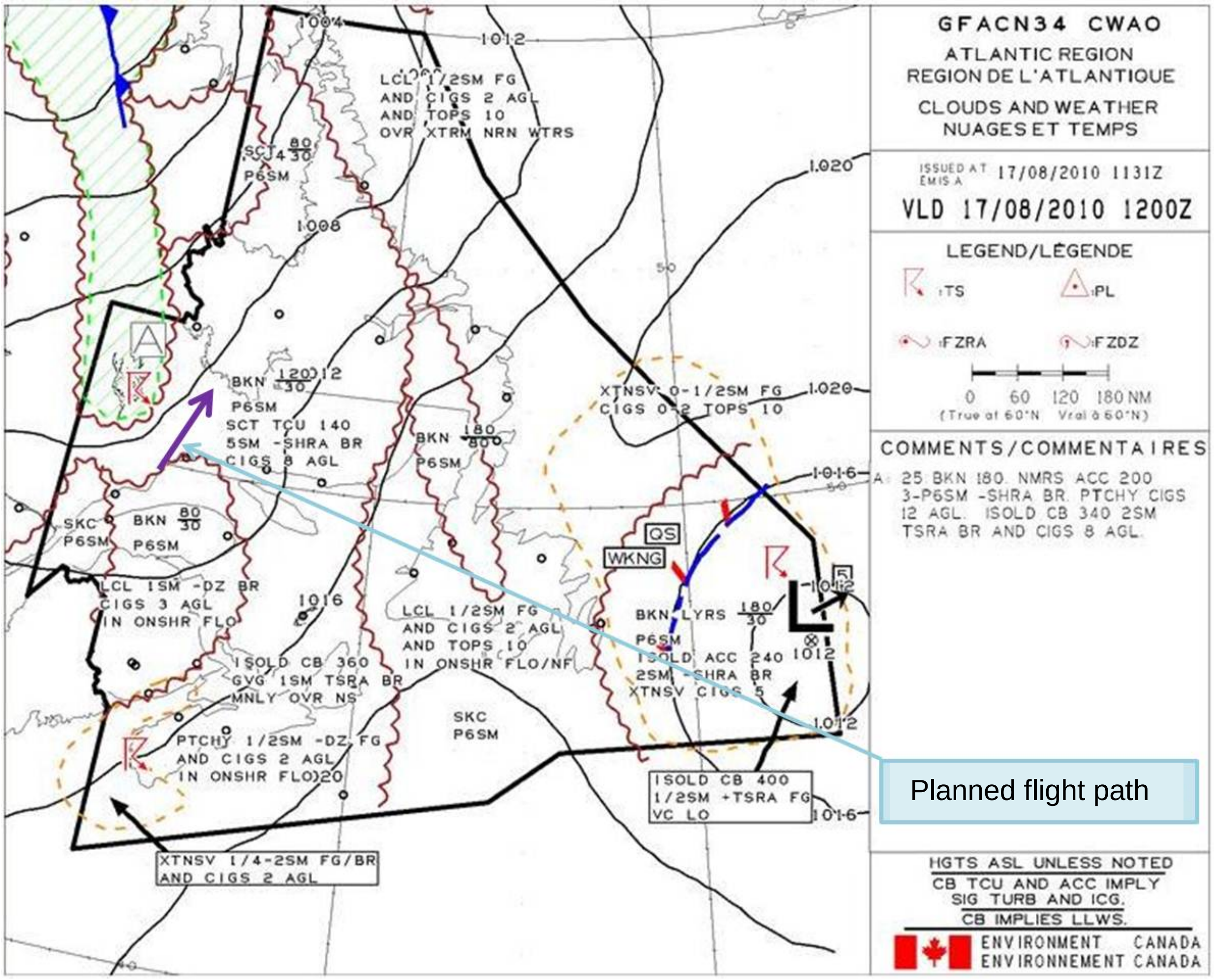
Appendices

Appendix A – Laboratory Reports

The following laboratory report was prepared for this investigation:

LP125/2010 – *Instrument Examination*

Appendix B – Graphical Area Forecast (GAF)



Appendix C – Weight and Balance Chart

Charte des poids et centre de gravité

S350 BA config: **été**

capa. Ext.:	4961 lbs	**C-GIYR**	2925,5 lbs.
capa. Int.:	4630 lbs.	C. de G. à vide	140,24 in.
capa.fuel à 100%	940 lbs.	CARGO (aft comp.)	90 lds.
FR. SEATS arm:	61,02 in.	PILOTE/PAX. (Avrg.)	200 lbs.
AFT SEATS arm:	99,99 in.	**poids de base**	3215,5 lbs.

Dart basket L/H
Amendment: **2**
Cofiguration: **3**

POIDS (lbs) CAPCACITE ELINGUE	% FUEL Qtée.	poids de base+ fuel (lbs.)	**gross weidht (lbs.)** capa. interne (lbs.) C. de G. (in.)	**Note:** Ajouter au **C. de G.** (in.) lorsque la / (les) combinaison(s) "Porte(s) enlevée(s)" a / (ont) lieu: Porte avant + arrière: **0.5** in. / Porte arrière seulement: **0.1** in.				
			pilote	**1 pax.**	**2 pax**	**3 pax**	**4 pax**	**5 pax**
1651	10	3310	**3310**	**3510**	**3710**	**3910**	**4110**	**4310**
			1320	1120	920	720	520	320
			136,5	132,2	130,4	128,9	127,5	126,2
1557	20	3404	**3404**	**3604**	**3804**	**4004**	**4204**	**4404**
			1226	1026	826	626	426	226
			136,5	132,3	130,6	129,1	127,7	126,4
1463	30	3498	**3498**	**3698**	**3898**	**4098**	**4298**	**4498**
			1132	932	732	532	332	132
			136,5	132,4	130,7	129,2	1046,6	126,6
1369	40	3592	**3592**	**3792**	**3992**	**4192**	**4392**	**4592**
			1038	838	638	438	238	38
			136,5	132,5	130,9	129,4	128,1	126,8
1275	50	3686	**3686**	**3886**	**4086**	**4286**	**4486**	
			944	744	544	344	144	
			136,5	132,6	131,0	129,6	128,3	127,0
1181	60	3780	**3780**	**3980**	**4180**	**4380**	**4580**	
			850	650	450	250	50	
			136,5	132,7	131,1	129,7	128,4	127,2
1087	70	3874	**3874**	**4074**	**4274**	**4474**		
			756	556	356	156		
			136,5	132,8	131,3	129,9	128,6	127,4
993	80	3968	**3968**	**4168**	**4368**	**4568**		
			662	462	262	62		
			136,5	132,9	131,4	130,0	128,8	127,6
899	90	4062	**4062**	**4262**	**4462**			
			568	368	168			
			136,5	133,0	131,5	130,2	128,9	127,8
805	100	4156	**4156**	**4356**	**4556**			
			474	274	74			
			136,5	133,1	131,6	130,3	129,1	127,9