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

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A19Q0153

LOSS OF CONTROL AND COLLISION WITH TERRAIN AT NIGHT

Cargair Ltd.
Cessna 172M, C-GSEN
Racine, Quebec
04 September 2019

Canada

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Summary

At 2103 Eastern Daylight Time on 04 September 2019, the Cargair Ltd. Cessna 172M aircraft (registration C-GSEN, serial number 17264779) departed Montréal International (Mirabel) Airport, Quebec, for a night visual flight rules flight to Sherbrooke Airport, Quebec, and back. The pilot was alone on board. At 2147, when the aircraft was approximately 19 nautical miles northwest of Sherbrooke Airport, it encountered instrument meteorological conditions and disappeared from radar. The wreckage was found on 07 September 2019 in a heavily wooded area near Racine, Quebec. The aircraft had struck trees and had been destroyed by impact forces. The pilot received fatal injuries on impact. There was no post-impact fire. No signal was detected from the emergency locator transmitter.

1.0 FACTUAL INFORMATION

1.1 History of the flight

On the evening of 04 September 2019, the occurrence pilot arrived at the Cargair Ltd. (Cargair) office located at Montréal International (Mirabel) Airport (CYMX), Quebec, along with another pilot,[1] to prepare for a night visual flight rules (VFR) flight. After reviewing the weather information, they prepared for a flight to Sherbrooke Airport (CYSC), Quebec, to conduct a touch-and-go and then return to CYMX. Both pilots would be conducting the same flight, but in separate aircraft.

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1 Both pilots had recently obtained their private pilot licence and completed the hours required to obtain a night rating endorsement.

At approximately 2000,[2] the pilots reviewed the flight plan and weather with a flight instructor and, after consultation with the chief flight instructor, the flight was authorized.

At 2101, the other pilot departed CYMX in a Cargair Cessna 172M aircraft (registration C-GUCU). The occurrence pilot departed CYMX at 2103 in another Cargair Cessna 172M aircraft (registration C-GSEN).

At 2106:10, once the occurrence aircraft was airborne and clear of the CYMX mandatory frequency (MF) area, the occurrence pilot contacted the Montréal area control centre (ACC) controller and requested a direct route to CYSC. The controller provided vectors to ensure the aircraft avoided aircraft arriving at Montréal/Pierre Elliott Trudeau International Airport, and instructed the occurrence pilot to climb to an altitude of 2500 feet above sea level (ASL). A few minutes later, the controller instructed her to climb to 3000 feet ASL.

At 2111:38, the controller provided the occurrence pilot with traffic information[3] about the other Cargair Cessna 172M aircraft, which was approximately 1 nautical mile (NM) ahead of the occurrence aircraft. Both aircraft were at an altitude of 3000 feet ASL. The occurrence pilot confirmed having the other Cargair aircraft in sight.

At approximately 2115, the controller instructed C-GSEN aircraft to proceed direct to CYSC.

At 2119:13, the controller instructed the occurrence pilot to climb to 3500 feet ASL, and provided the position of the other Cargair aircraft, which was still approximately 1 NM ahead of the occurrence aircraft and also climbing to 3500 feet ASL.

At approximately 2124, both aircraft were informed that they were leaving controlled airspace and were instructed to switch to the enroute frequency.[4,5]

The occurrence aircraft was travelling slightly faster than the other Cargair aircraft, and at approximately 2132, the occurrence aircraft passed the other Cargair aircraft. Both aircraft continued the flight towards CYSC, with the occurrence aircraft now ahead of the other Cargair aircraft.

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

3 Traffic information is "information issued by ATS [air traffic services] to pilots regarding other known or observed traffic that may be in such proximity to their position or intended route as to warrant their attention." (Source: NAV CANADA, TERMINAV terminology database, at http://www1.navcanada.ca/logiterm/addon/terminav/termino.php [last accessed on 17 July 2020].)

4 As stated in the *Transport Canada Aeronautical Information Manual*, "[p]ilots operating VFR [visual flight rules] en route in uncontrolled airspace when not communicating on an MF [mandatory frequency], or an ATF [aerodrome traffic frequency], or VFR on an airway should continuously monitor 126.7 MHz and whenever practicable, broadcast their identification, position, altitude and intentions on this frequency to alert other VFR or IFR [instrument flight rules] aircraft that may be in the vicinity." (Source: Transport Canada, TP 14371, *Transport Canada Aeronautical Information Manual* (TC AIM), RAC – Rules of the Air and Air Traffic Services (10 October 2019), section 5.1.)

5 No weather updates were provided to the aircraft at that time.

At approximately 2142, the occurrence aircraft entered instrument meteorological conditions (IMC)[6] and descended to an altitude of 3000 feet ASL to return to visual meteorological conditions (VMC). The other Cargair aircraft encountered the same conditions and descended as well. Both aircraft were approximately 32 NM northwest of CYSC at the time, and continued the flight towards CYSC in level flight at 3000 feet ASL.

Shortly after descending to 3000 feet ASL, the other Cargair aircraft lost sight of the occurrence aircraft as the occurrence aircraft flew into IMC for a second time. At 2147, the occurrence aircraft disappeared from radar when it was approximately 19 NM northwest of CYSC. After the other Cargair aircraft also encountered IMC a second time, the pilot decided to return to CYMX.

The wreckage of the occurrence aircraft was located 3 days later, on 07 September 2019, in a heavily wooded area near Racine, Quebec (Figure 1), at an elevation of 887 feet ASL. The aircraft had struck trees and had been destroyed by impact forces. The pilot received fatal injuries on impact. There was no post-impact fire. No signal was detected from the emergency locator transmitter (ELT).

Figure 1. Aerial view of the wreckage site (Source: Sûreté du Québec)

[6] "Meteorological conditions less than the minima specified […], expressed in terms of visibility and distance from cloud [for VFR flight in the *Canadian Aviation Regulations*]." (Source: Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, subsection 101.01)

1.2 Injuries to persons

Table 1. Injuries to persons

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

1.3 Damage to aircraft

The aircraft was destroyed by impact forces. There was no post-impact fire.

1.4 Other damage

The occurrence aircraft impacted a heavily wooded area. Several trees were damaged from the impact. The investigation was unable to determine the amount of fuel spilled due to the elapsed time between the accident and the arrival of search and rescue personnel.

1.5 Personnel information

The pilot held a private pilot licence – aeroplane, which had been obtained in July 2019, and a valid Category 3 medical certificate. The pilot had completed the hours required to obtain a night rating endorsement[7] on 27 August 2019. Although the pilot was certified and qualified for the flight in accordance with existing regulations, at the time of the occurrence her licence had not yet been endorsed with a night rating. See section 1.18.1.2 for details about the night rating endorsement.

7 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Standard 421 – *Flight Crew Permits, Licences and Ratings*, Division XII – *Night Rating*, subsection 421.42(1).

Table 2. Personnel information

	Pilot
Pilot licence	Private pilot licence (PPL)
Date of qualifying flight to obtain night rating*	27 August 2019
Medical expiry date	01 September 2023
Total flying hours	87.2
Flight hours on type	87.2
Total flight hours, dual	64.7
Total flight hours, solo	22.5
Flight hours, night dual	6.9
Flight hours, night solo	5.3
Flight hours, instrument	12.6

* According to subsection 101.01(1) of the *Canadian Aviation Regulations*, "night means the time between the end of evening civil twilight and the beginning of morning civil twilight." On 04 September 2019, evening civil twilight ended at 1950 in Sherbrooke, Quebec.

1.6 Aircraft information

Records indicate that the aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures. The aircraft's weight and centre of gravity were within the prescribed limits at the time of the occurrence. Nothing was found to indicate an airframe failure or system malfunction either before or during the flight.

Table 3. Aircraft information

Manufacturer	Cessna Aircraft Company
Type, model and registration	Cessna 172M, C-GSEN
Year of manufacture	1975
Serial number	17264779
Certificate of airworthiness/flight permit issue date	24 March 2004
Total airframe time	14 404.1
Engine type (number of engines)	Lycoming O-320E2D (1)
Propeller type (number of propellers)	McCauley FP/1C160/DTM (1)
Maximum allowable takeoff weight	2300 lb
Recommended fuel type(s)	100/130, 100LL
Fuel type used	100 LL

1.7 Meteorological information

Environment and Climate Change Canada performed an in-depth analysis of the weather conditions affecting the Racine, Quebec, area at the time of the occurrence.[8] The following

8 Environment and Climate Change Canada, *Meteorological Assessment 4-5 September 2019, Racine, Québec* (26 November 2019).

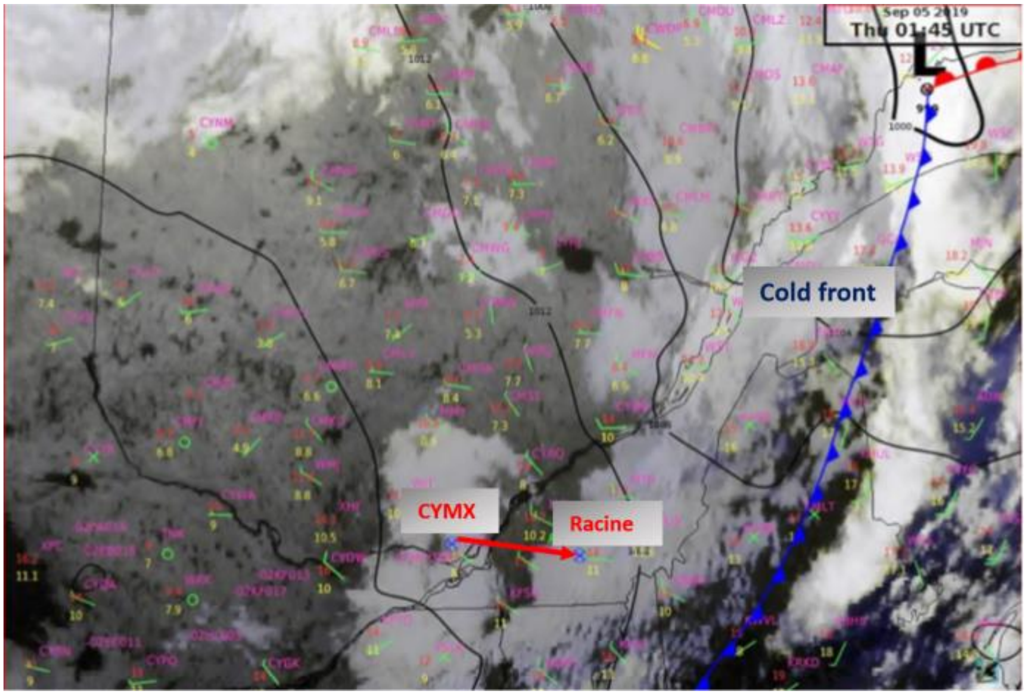
sections of the report are based on Environment and Climate Change Canada's analysis as well as aviation weather information available to pilots on-line or by communicating with a flight service specialist.

1.7.1 Surface observations

At 2000 on 04 September 2019, a low-pressure system was centered near the Gaspé Peninsula, about 60 NM northeast of the Mont-Joli Airport, Quebec. A warm front extended from the low-pressure system eastward into eastern Quebec and a cold front extended south through the U.S. state of Maine. A ridge of high pressure, located to the west, had moved eastward extending its influence into southwestern Quebec. At 2100, before the occurrence aircraft departed CYMX, the area between CYMX and CYSC remained under a stratocumulus cloud deck behind the cold front. Although the winds had died down and the skies had started to clear at CYMX , the skies remained overcast near CYSC, with gusty westerly winds.

At approximately the time of and near the area of the occurrence, precipitation-rain radar images showed convective cloud embedded within the stratocumulus cloud, as well as possible light showers. Images also showed the presence of shallow towering cumulus (TCU) cloud embedded within the stratocumulus layer (Figure 2).

Figure 2. Multi-spectral satellite imagery valid at 2145 on 04 September 2019 depicting cold front (Source: Environment and Climate Change Canada, with TSB annotations)



1.7.2 Graphic area forecast

Graphic area forecasts (GFAs) show the general upcoming weather conditions for a given geographic area.[9] On the day of the occurrence, a clouds and weather chart issued at 1331 and valid at 2000, showed a low-pressure system located near Baie-Comeau, in eastern Quebec, with a cold front extending south into the U.S., moving eastward at 20 knots. The cold front was forecast to be west of CYSC at 2000 (Appendix A).

In the vicinity of the cold front, the following conditions were expected:

- broken ceilings at 3000 feet ASL, with tops at 24 000 feet ASL;
- visibility variable between 4 and more than 6 statute miles (SM);
- light rain and mist;
- occasional altocumulus castellanus with tops at 22 000 feet, giving visibilities of 2 SM in light rain showers;
- patchy ceilings between 300 and 600 feet above ground level (AGL);
- isolated cumulonimbus clouds with tops at 36 000 feet ASL, giving visibility of 1 SM in heavy thundershowers and mist; and
- winds gusting to 35 knots.

Behind the cold front, the following conditions were expected:

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[9] Graphic area forecasts are issued 4 times a day and are valid for 12 hours. Two charts are issued for each indicated period: one chart describes clouds and weather and the other describes icing, turbulence and freezing levels.

- broken ceilings at 3000 feet ASL, with tops at 6000 feet ASL;
- visibility of more than 6 SM;
- isolated altocumulus castellanus with tops at 20 000 feet ASL, visibility of plus 6 SM in light rain showers and mist; and
- over eastern/southern sections, local ceilings at 1500 feet AGL.

At 1911, a revised GFA (Appendix B) was issued with similar conditions to those depicted in the GFA issued at 1331, with the following exceptions:

- The cold front was forecast to be east of CYSC at 2000; and
- over eastern/southern sections, isolated TCU with tops at 8000 feet ASL, visibility of 5 SM in light rain showers, mist and patchy ceilings between 800 and 1500 feet AGL.

1.7.3 Sherbrooke aerodrome routine meteorological reports and aerodrome forecasts

Aerodrome routine meteorological reports (METARs) for CYSC are collected by an automated weather observation system (AWOS). METARs and aerodrome special meteorological reports (SPECIs), that are based on data collected from an automatic system, contain the qualifier AUTO.

The CYSC METAR AUTO issued at 2000 on 04 September 2019 reported the following:

- wind 280° true (T) at 17 knots, gusting to 29 knots;
- visibility more than 9 SM;
- a few clouds at 2800 feet AGL, a broken ceiling at 3900 feet AGL, and an overcast layer at 4800 feet;
- temperature 17 °C, dew point 12 °C; and
- altimeter setting 29.85 inches of mercury.

At 2058, a few minutes before the aircraft departed from CYMX, a SPECI was issued. It reported the following:

- wind 280°T at 11 knots, gusting to 22 knots;
- visibility more than 9 SM;
- broken ceiling at 2100 feet AGL, with additional broken layers at 3200 feet AGL and 4900 feet AGL;
- temperature 15 °C, dew point 12 °C; and
- altimeter setting 29.92 inches of mercury.

Between 2100 and 2200, while the occurrence aircraft was in flight, the AWOS issued 4 SPECIs, at 2101, 2112, 2115 and 2138, indicating changes in the cloud cover. Weather sequences are found in table 4.

Table 4. Aerodrome routine meteorological reports (METARs) and aerodrome special meteorological reports (SPECIs) issued at Sherbrooke Airport

Weather report		Winds		Visibility (SM)	Precipi-tation	Cloud layers*			Temper-ature (°C)	Dew point (°C)	Altimeter (in Hg)
Type	Time issued	Direction (°T)	Wind and gust (G) speeds (knots)			First	Second	Third			
METAR	2100	290	10G22	9	None	2300 feet; broken*	3200 feet broken	4900 feet overcast	15	12	29.91
SPECI	2101	290	10G22	9	None	2300 feet; scattered	2700 feet broken	4900 feet overcast	15	12	29.91
SPECI	2112	280	20	9	None	2100 feet; scattered	3200 feet broken	-----	15	11	29.92
SPECI	2115	280	13G24	9	Light rain	2300 feet; few	3000 feet overcast	-----	14	11	29.92
SPECI	2138	280	12G23	9	None	3200 feet; overcast	-----	-----	14	11	29.94
METAR	2200	280	13	9	None	2300 feet; few	3400 and 4200 feet broken	5000 feet overcast	14	11	29.95

* The base of the cloud layers is reported as the height above the station in increments of 100 feet to a height of 10 000 feet, and thereafter in increments of 1 000 feet. The cloud layers are reported in eighths (oktas) of sky coverage as follows: few clouds is less than 1/8 to 2/8 summation amounts; scattered 3/8 to 4/8 summation amounts; broken 5/8 to less than 8/8 summation amounts; overcast 8/8 summation amounts.

Aerodrome forecasts (TAFs) provide a description of the most probable weather conditions expected to occur, within a 5 NM radius around an aerodrome, and are amended when the forecast conditions are no longer representative of the current or expected conditions (i.e., the conditions improve or deteriorate).

The TAF issued for CYSC at 1943 on 04 September 2019, which was valid from 2000 until 2300, forecasted the following conditions:

- winds from 270°T at 15 knots, gusting to 25 knots;
- visibility of more than 6 SM;
- broken ceiling at 4000 feet AGL;
- broken cloud layer at 7000 feet AGL; and
- a gradual change to winds was forecast to occur between 2000 and 2200, when winds were forecast to decrease to 280°T at 10 knots.

1.8 Aids to navigation

The pilot used the ForeFlight Mobile application on a tablet for navigation, and had an active online ForeFlight account. When activated by the pilot, the application can log certain flight data, such as speed, altitude, and itinerary by using a mobile device’s GPS (global positioning system). The online account can store information from previous flights, if the option is activated. Data is normally stored on the device's internal memory and transferred to the online account when connected to Wi-Fi or, in some cases, to a cellular network.

Although ForeFlight is widely used by pilots, it is not part of the private pilot licence curriculum, and there is no regulatory requirement that would mandate flight training units to include it in their curriculum. However, a licenced pilot on a solo flight at Cargair has the option of using ForeFlight as an aid to navigation.

The data for the occurrence flight were probably still on the tablet's internal memory at the time of the accident. However, the tablet was not recovered from the wreckage and the pilot's mobile device used to connect the tablet to the internet was too severely damaged by the impact forces for TSB Engineering Laboratory specialists to recover the data.

1.9 Communications

No distress message was heard, or recorded, on the 121.5 MHz emergency frequency.

1.10 Aerodrome information

Not applicable.

1.11 Flight recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor were such recorders required by regulations.

1.12 Wreckage and impact information

1.12.1 Accident site

The accident site was in a heavily wooded area near Racine, Quebec. The aircraft's wings first struck 2 tall evergreen trees. Damage to the trees indicate that the aircraft was travelling at high velocity in a nose-down, banked attitude before it struck them (Figure 3).

Figure 3. Damage to trees caused by the occurrence aircraft looking back towards the direction of flight (Source: Sûreté du Québec, with TSB annotation)

After the first strike, the aircraft collided head on with a hardwood tree. The aircraft's fuselage wrapped around the tree's trunk before striking the ground, inverted, on the opposite side. All flight control surfaces were accounted for and came to rest scattered within a restricted perimeter from the point of impact, indicating that the aircraft broke up on impact and not in flight. There were no signs of pre-impact failures of material or component malfunctions.

Damage to the propeller as well as the number and proximity of the propeller marks on the tree's trunk were consistent with power being produced at the time of impact. The throttle was found to be in the full-power position.

1.12.2 Instrument analysis

The instruments recovered from the wreckage were sent to the TSB Engineering Laboratory in Ottawa, Ontario, for analysis. The damage observed on the instruments was indicative of high deceleration forces at impact. Even though the protective glass on the instruments was either missing or shattered and the dial faces were deformed, the engine tachometer, the airspeed indicator, the vertical speed indicator, and the directional gyroscope were examined.

1.12.2.1 Engine tachometer

The engine tachometer was found with the pointer missing. The TSB laboratory carried out a microscopic examination of the tachometer's face, and a clear pointer-to-face mark was observed extending from the pointer shaft to the 2850 rpm gradation, 150 rpm over the red-line limit. The engine tachometer is a mechanical instrument driven by a torsion cable that is connected to the engine's tachometer drive housing and, as such, does not require electrical power to operate. It will provide a reading as long as the engine is turning. Therefore, the 2850 rpm pointer-to-face witness marks are considered to be an accurate representation of engine revolution at the time of impact.

1.12.2.2 Airspeed indicator

The airspeed indicator was found still attached to the instrument panel. Although the pointer was missing, the examination revealed a faint pair of parallel lines, possibly caused by the pointer striking or being pressed against the dial face. These lines were at or near the pointer stop of 200 mph (174 knots indicated airspeed (KIAS)), indicating that the aircraft likely had exceeded the never exceed speed (Vne) of 184 mph (160 KIAS).

1.12.2.3 Vertical speed indicator

The vertical speed indicator was severely damaged; however, a microscopic examination revealed a faint sequence of impact marks extending radially from the center of the dial and roughly aligning with a 1900 fpm descent rate, nearing the maximum indicated rate of descent of 2000 fpm.

1.12.2.4 Directional gyroscope

The directional gyroscope, or heading indicator, incorporates a gyroscope that is oriented in such a way as to hold its position in azimuth and, through gears, drives a compass card located behind a protective glass at the front of the instrument. As the aircraft changes heading, the compass card turns accordingly. Examination of the directional gyroscope determined that the instrument had a recorded heading of approximately 280° at impact, which is a 165° change in direction from the occurrence aircraft's last radar track of 115°.

1.13 Medical and pathological information

There was nothing to indicate that the pilot's performance was degraded by fatigue or any other pre-existing medical, pathological, or physiological factors.

1.14 Fire

There was no indication of a pre- or post-impact fire.

1.15 Survival aspects

1.15.1 General

After losing sight of the occurrence aircraft, the pilot of the other Cargair aircraft attempted to reach the occurrence aircraft via the aircraft radio. When no response was heard, she attempted to reach the occurrence pilot by calling her cellular phone and then contacted Cargair. Once informed that contact with the occurrence aircraft had been lost, Cargair activated its emergency procedures, and actions were taken to find the aircraft. This included contacting NAV CANADA.

At 0004:18 on 05 September 2019, NAV CANADA issued an uncertainty phase notice[10] for the occurrence aircraft. Then, at 0034:12, an alert phase notice[11] was issued. After a communication search proved to be unsuccessful, and after confirming that the aircraft was not on the ground at CYSC, NAV CANADA provided information about the missing aircraft to the Joint Rescue Coordination Centre in Trenton, Ontario, and, at 0134:01, the notice was changed to the distress phase notice.[12]

The wreckage was found by a search party in the early afternoon on 07 September 2019. The aircraft had struck trees and had been destroyed by impact forces. The impact was not survivable and the pilot received fatal injuries during the impact sequence.

No signal was detected from the ELT.

1.15.2 Emergency locator transmitter

The occurrence aircraft was equipped with an automatic fixed ELT,[13] capable of transmitting on 121.5 MHz and 243 MHz only. ELT signals on 121.5 MHz or 243 MHz can be detected by other aircraft or air traffic control (ATC) monitoring those frequencies, but are no longer monitored by Cospas-Sarsat.[14,15] In this occurrence, no ELT signals were reported on 121.5 MHz or 243 MHz by other aircraft or by ATC.

The ELT was sent to the TSB Engineering Laboratory for analysis. It was determined that the ELT was likely serviceable in the moments leading up to the impact. However, damage to the battery pack, mode selector switch, and antenna coaxial cable, individually or combined, would have immediately interrupted transmission capabilities, making detection of an ELT distress signal impossible (Figure 4).

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[10] An uncertainty phase notice is issued during the uncertainty phase, which is defined as "[a] situation wherein uncertainty exists as to the safety of an aircraft and its occupants." (Source: NAV CANADA, TERMINAV terminology database, at http://www1.navcanada.ca/logiterm/addon/terminav/termino.php [last accessed on 23 November 2020].)

[11] An alert phase notice is issued during the alert phase, which is defined as "[a] situation wherein apprehension exists as to the safety of an aircraft and its occupants." (Source: NAV CANADA, TERMINAV terminology database, at http://www1.navcanada.ca/logiterm/addon/terminav/termino.php [last accessed on 23 November 2020].)

[12] A distress phase notice is issued during the distress phase, which is defined as "[a] situation wherein there is reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance." (Source: NAV CANADA, TERMINAV terminology database, at http://www1.navcanada.ca/logiterm/addon/terminav/termino.php [last accessed on 23 November 2020].)

[13] Dorne & Margolin emergency locator transmitter (ELT), model C589511-0117.

[14] Cospas-Sarsat is an international satellite-based monitoring system that detects distress signals from emergency locator beacons on aircraft or vessels within Canada's search-and-rescue area of responsibility.

[15] On 03 November 2020, SOR/2020-238, proposed amendments to the *Canadian Aviation Regulations* (CARs) subsection 605.38(1) were published in the *Canada Gazette*, Part II. These amendments have provisions that will mandate aircraft to be fitted with ELTs that are able to transmit on 406 MHz and 121.5 MHz simultaneously.

Figure 4. Occurrence aircraft's emergency locator transmitter (Source: TSB)

1.16 Tests and research

1.16.1 TSB laboratory reports

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

- LP 220-2019 – Instrument Analysis
- LP 221-2019 – ELT Analysis
- LP 224-2019 – NVM Data Recovery – GPS and Cellphone
- LP 288-2019 – Radar Analysis

1.17 Organizational and management information

Not applicable.

1.18 Additional information

1.18.1 Night flight

1.18.1.1 Regulatory requirements for night flight

According to the *Canadian Aviation Regulations* (CARs), pilots in VFR flight within or outside controlled airspace must operate their aircraft with visual reference to the surface, during the day and at night.[16] The CARs define a surface as "any ground or water, including the frozen surface thereof."[17]

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16 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, paragraph 602.114(a).

17 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, section 101.01.

In addition to the visual reference to the surface required for night VFR flight in an aircraft in uncontrolled airspace, the following conditions must be met:

- flight visibility is not less than 3 miles;
- if the aircraft is operated at or above 1000 feet AGL, the distance from cloud is not less than 500 feet vertically and 2000 feet horizontally; and
- if the aircraft is operated at less than 1000 feet AGL, it must stay clear of cloud.[18]

Following the TSB investigation[19] into a helicopter crash where the flight had departed under night VFR from Moosonee, Ontario, a remote airport with minimal nearby lighting, the TSB raised concerns with the lack of clarity in the practical meaning of the definition of a "flight with visual reference to the surface." The Board recommended that

> The Department of Transport amend the regulations to clearly define the visual references (including lighting considerations and/or alternate means) required to reduce the risks associated with night visual flight rules flight.
>
> **TSB Recommendation A16-08**

The TSB's most recent published assessment of TC's response to Recommendation A16-08 was completed in February 2021 and was rated as **Satisfactory Intent**.[20]

TC has indicated that it is in the process of drafting 2 notices of proposed amendment (NPAs) that would lead to updates to the night VFR requirements and changes that would require 2 levels of night rating. TC expects these NPA packages to be completed by mid-2021. TC also published an updated version of Advisory Circular (AC) 603-001 – *Special Authorization for Night Vision Imaging Systems*, as well as articles in issues of the *Aviation Safety Letter* to educate pilots and raise awareness of the risks associated with night VFR flights.

Since May 2013, the TSB has investigated 6 other fatal accidents involving private aircraft on night VFR flights.[21] The investigation reports highlighted the lack of clarity in the regulations regarding visual references.

1.18.1.2 Night flight training

A night rating endorsement qualifies a private pilot to fly unsupervised during the hours of official darkness. To obtain this endorsement, a pilot must meet the requirements set out in Standard 421.42 of the CARs, including the following:

> (1) Private Pilot Licence – Aeroplane

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18 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, section 602.115.

19 TSB Aviation Investigation Report A13H0001.

20 For further details relating to this recommendation, along with Transport Canada's responses to the recommendation and the TSB's assessment of these responses, visit https://www.bst-tsb.gc.ca/eng/recommandations-recommendations/aviation/2016/rec-a1608.html (last accessed 02 February 2021).

21 TSB air transportation safety investigation reports A19O0178, A19O0026, A18Q0016, A17O0209, A15O0188, and A14O0217.

> (a) **Experience**
>
> An applicant for a night rating shall have acquired in aeroplanes a minimum of 20 hours of pilot in command flight time which shall include a minimum of:
>
> (i) 10 hours of night flight time including a minimum of:
>
> (A) 5 hours dual flight time, including 2 hours of cross-country flight time
>
> (B) 5 hours solo flight time, including 10 takeoffs, circuits and landings, and
>
> (ii) 10 hours dual instrument time.
>
> (iii) Credit for a maximum of five hours of the 10 hours of dual instrument flight time may be given for instrument ground time, provided that the total instrument time shall be in addition to the 10 hours night flight time in subparagraph (a)(i) above.
>
> (b) **Skill**
>
> Within the 12 months preceding the date of application for a night rating, an applicant shall have successfully completed a qualifying flight under the supervision of a Transport Canada Inspector or a person qualified in accordance with subsection 425.21(4) by demonstrating the level of skill specified in the Flight Instructor Guide-Aeroplane (TP 975).[…][22]

Therefore, a pilot can complete 5 hours of flight time on a simulator, 5 hours of daytime dual instrument flight time with a visor (used to limit vision outside the aircraft), and 10 hours of actual night flight before sending an application to TC to obtain a night rating.

The regulations and standards do not require pilots to complete in-flight testing to obtain a night rating. However, as stated in CARs Standard 421.42(1)(b), a qualifying flight must be completed within the 12 months before an application for a night rating is submitted. The CARs do not define what constitutes a qualifying flight.

Although guidance in the *Flight Instructor Guide – Aeroplane* (TP 975) recommends that theoretical ground training be given on topics specific to night flight—such as spatial disorientation, optical and sensory illusions, night vision, human factors, and pilot decision making—the regulations in effect at the time of the accident did not require it. The instructor is the person who certifies that the applicant is competent for night flying. However, the notion of competency is not defined by specific criteria in the regulations. None of the information collected made it possible for the investigation to determine whether the pilot had acquired theoretical knowledge on the specifics of night flight during her night flight training.

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22 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Standard 421 – *Flight Crew Permits, Licences and Ratings*, Division XII – *Night Rating*, section 421.42.

Standard 421.42(1) requires applicants with a private pilot licence to demonstrate the "level of skill specified in the *Flight Instructor Guide – Aeroplane* (TP 975)." TP 975 states the following in Exercise 25 – Night Flying:

> **Instrument flying**
>
> A certain amount of instrument flying is needed for the night rating, because there are some night situations in which instruments are almost the only attitude reference available. Private pilot training now requires five hours of dual instrument flying, so this much can be counted on, unless the candidate completed private pilot training many years ago. Many instructors like to do at least some of this instrument flying at night, although it will not be counted as part of the five hours dual flight time needed for the rating. In addition, if the equipment is available, it is recommended that they learn more about radio aids to navigation than is required for the Private Pilot Licence. This might include the ability to use VOR [very high frequency omnidirectional range], ADF [automatic direction finder] or GPS to determine a position and to home to the facility or waypoint.
>
> **Recommendation for the night rating**
>
> There is no flight test required for the night rating, but the instructor is expected to know when the student is competent to exercise the privileges of the rating, which is more than simply acquiring the necessary dual and solo flight time. The student should be able to meet, for those exercises covered in night flying, the same standard set out in the Flight Test Standards, Private and Commercial Pilot Licences — Aeroplane (TP 2655E).[23]

1.18.1.3 Night rating endorsement

Once applicants have completed their training, they have up to 12 months following the date of their qualifying flight to submit their night rating endorsement application to TC. The occurrence pilot had completed the hours required to obtain a night endorsement on 27 August 2019; the flight instructor had signed the application form on 01 September 2019, and the occurrence pilot had signed it on 03 September 2019. At the time of the occurrence, the night rating endorsement application had not been submitted to a TC-authorized person for signature.

Nevertheless, the occurrence flight met the definition of a training flight as stated in CARs section 400.01: "training flight means a dual instruction or a solo practice flight that is conducted under the direction and supervision of a flight instructor."[24]

1.18.2 Pilot decision making

Pilot decision making is a cognitive process consisting of gathering information, evaluating it, then selecting an option between alternatives. Once a course of action is being performed, the decision-making process starts again in order to validate whether the decision made corresponds to the best possible option. Decision making is therefore a dynamic process. By

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[23] Transport Canada, TP 975, *Flight Instructor Guide* (revised September 2004), Exercise 25 – Night Flying, p. 172.

[24] Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, subsection 401.01(1).

anticipating and addressing possible issues that could occur during the flight, pre-flight planning decisions avoid the need for potentially more difficult in-flight decisions. This is particularly critical for night VFR flights, when considering the risk of encountering adverse weather.

Throughout pilot training, instructors play a vital role in teaching pilots how to make decisions. Pilots with limited experience can lack the experience necessary to clearly recognize hazards and options available to them. They often rely on their instructor's judgement and experience to guide them and teach them how to assess various situations and associated hazards. It is therefore important for an instructor to emphasize how to identify hazards ahead of time and show the pilot how to assess the associated risks and determine acceptable limits.

Cross-country flights require that pilots apply several theoretical subjects they have studied during their training, such as flight planning, meteorology, human factors, regulations, and multi-tasking.

According to an educational package from TC,[25] pilot decision making varies depending on how much time the pilot has to act:

- Before the flight, there is "ample time decision making."
- During the flight, there is "time critical decision making," since a quick decision and reaction is necessary, often based on similar previous experience or one that was simulated during training.

Once a flight has begun, an instructor cannot correct time-critical decisions made by the pilot. Also, inexperienced pilots "are less able to recognize and accurately interpret a situation, they are more often forced into knowledge-based behavior"[26] rather than experience-based behavior. Since their knowledge is generally more limited, "they are more likely to make knowledge-based mistakes."[27]

In this occurrence, the pilot had limited night and instrument flight experience and knowledge of the risks associated with night flying.

A number of cognitive biases can also influence pilot decision making. Plan continuation bias is best described as "the unconscious cognitive bias to continue with the original plan in spite of changing conditions,"[28] or "a deep-rooted tendency of individuals to continue

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25 Transport Canada, TP 13897, *Pilot Decision Making* (February 2002), Module 2: The Decision-making Process, p. 3.

26 Transport Canada, TP 13897, *Pilot Decision Making* (February 2002), Module 2: The Decision-making Process, p. 5.

27 Transport Canada, TP 13897, *Pilot Decision Making* (February 2002), Module 2: The Decision-making Process, p. 5.

28 Skybrary, "Continuation Bias", at http://www.skybrary.aero/index.php/Continuation_Bias (last accessed on 22 July 2019).

their original plan of action even when changing circumstances require a new plan."[29] Once a plan is made and committed to, it becomes increasingly difficult for stimuli or conditions in the environment to be recognized as necessitating a change to that plan. Often, as workload increases, the stimuli or conditions will appear obvious to people external to the situation; however, it can be very difficult for a pilot caught up in the plan to recognize the saliency of the cues and the need to alter the plan.[30] Plan continuation bias can be a factor for continued flight in adverse weather conditions.

1.18.3 Encountering weather at night

At night, it is more difficult to visually detect and stay clear of cloud, terrain and obstacles. Unlike on day VFR flights, weather phenomena are difficult to observe at night because of the low-light conditions. It is possible that pilots departing in weather conditions that legally permit night VFR flight would be unable to observe a deterioration in weather conditions and take the necessary measures before inadvertently entering IMC. The consequences of flying in reduced visibility are exacerbated when flying at night, in light conditions that do not permit sufficient warning for the pilot to see and avoid worsening weather conditions.

TC's *Flight Training Manual* states the following:

> During the day there is little possibility of flying into a cloud condition accidentally. On dark, overcast night, however, it can be done easily. Be alert to the possibility of the existence of cloud in the area. At night it may be detected or suspected by the otherwise unwarranted disappearance of lights on the ground and by a red or green glow adjacent to the position lights of the aircraft.[31]

Pilots can take steps to minimize the likelihood that they will inadvertently enter IMC when the actual conditions cannot be seen. To that effect, the CARs state that the pilot-in-command of an aircraft "must be familiar with the available weather information that is appropriate to the intended flight."[32]

In this occurrence, the pilot had obtained weather information for the flight-planned route on the internet and had reviewed it with a flight instructor. The forecasted weather conditions met regulatory requirements for a night VFR flight; however, the review raised some concerns regarding the prevailing winds at CYSC. After discussion, the pilot and instructor determined that the weather was sufficient for the proposed flight to CYSC, and

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29 B. Berman and R. K. Dismukes, "Pressing the approach," *Aviation Safety World*, Flight Safety Foundation, Volume 1, Issue 6 (December 2006), pp. 28–33.

30 E. Muthard and C. Wickens, "Factors that mediate flight plan monitoring and errors in plan revision: Planning under automated and high workload conditions," presented at the *12th International Symposium on Aviation Psychology* (Dayton, Ohio, United States, 14–17 April 2003).

31 Transport Canada, TP 1102, *Flight Training Manual*, 4th edition (revised 2004), Exercise 25, Night Flying, p.178.

32 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, section 602.72.

agreed that the pilot would not attempt to land if the winds were too strong. The chief flight instructor was consulted and then the flight was authorized.

A post-occurrence review of the METARs and TAFs that were available at the time of flight planning detailed ceilings that were, or were expected to be, above the planned cruise altitude of 3500 feet ASL. Although the METARs and TAFs described favourable conditions, the available GFA detailed that ceilings in the flight plan area were expected to be broken at 3000 feet ASL, below the planned cruise altitude. It could not be determined which, if any, GFA was reviewed at the time the flight was planned.

This GFA forecast was later determined to be accurate (following the occurrence), as the METAR issued shortly before the occurrence aircraft departed CYMX, recorded the ceiling at CYSC as 2100 feet AGL, or approximately 2900 feet ASL.

1.18.4 Spatial disorientation

There are a number of hazards associated with night flying. First and foremost, visual performance is significantly degraded under conditions of night illumination. Even under ideal night VFR conditions with a full moon, a pilot likely has a visual acuity[33] in the order of 20/200 or less. This means that a person can see at 20 feet what he or she would normally be able to see at 200 feet in daylight.[34]

This degraded visual performance can create compelling sensory illusions that can lead to spatial disorientation, which is defined as "the inability of a pilot to correctly interpret aircraft attitude, altitude or airspeed in relation to the Earth or other points of reference."[35] In other words, spatial disorientation occurs when a person's brain misinterprets cues from the environment, and that person experiences difficulty resolving mentally why, for instance, an aircraft does not appear to be doing what the brain believes that it is doing. If pilots do not quickly detect and control this spatial disorientation, they can rapidly lose control of the aircraft.

Humans have the ability to discern the orientation of their body (lying down, standing, leaning, etc.) when they are in physical contact with the ground. Humans are not accustomed to the 3-dimensional environment of flight, and conflicts may arise between the senses and illusions that make it difficult or impossible to maintain spatial orientation.

Humans process information from 3 sensory systems to orient themselves in space:

- the visual system;
- the vestibular system (information from the inner ear); and

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33 Visual acuity refers to the clarity of vision.

34 United States Department of Transportation, Federal Aviation Administration, *Pilot's Handbook of Aeronautical Knowledge* (Oklahoma, 2016), p. 17-21.

35 Australian Transport Safety Bureau, ATSB Transport Safety Investigation Report – Aviation Research and Analysis Report B2007/0063: *An overview of spatial disorientation as a factor in aviation accidents and incidents*, (Canberra City, Australia, 2007), p. vii.

- the proprioceptive system (information from muscles, joints and bones).

The visual system provides 80% of the information used for spatial orientation. If visual information is lost, all that remains is the 20% of information that comes from the vestibular and proprioceptive systems. The information from these 2 systems is less precise and more susceptible to error, because they are prone to illusions and misinterpretation.

Since visual cues play an important role in human balance and orientation, spatial disorientation tends to occur in conditions of limited visibility; pilots can rapidly become spatially disoriented when they lose sight of the surface. To this effect, a report published by the Australian Transport Safety Bureau (ATSB)[36] stated the following:

> The significance of visual cues on human balance and orientation may be demonstrated by the short period of time it takes for a person to become spatially disoriented once visual cues are lost:
>
> > 'Disorientation is very uncommon when the pilot has well-defined visual cues; but when he attempts to fly when sight of the ground or horizon is degraded by cloud, fog, snow, rain, smoke, dust or darkness he quickly becomes disorientated unless he transfers his attention to the aircraft instruments. The ability to maintain control of an aircraft without adequate visual cues is quite short, typically about 60 seconds, even when the aircraft is in straight and level flight at the time vision is lost and shorter still if the aircraft is in a turn. In such circumstances, loss of control occurs because the non-visual receptors give either inadequate or erroneous information about the position, attitude and motion of the aircraft.'
> > (Benson, A.J. *Spatial Disorientation – General Aspects*, 1988)[37]

In a degraded visual environment (such as intentionally or inadvertently flying into IMC), where a pilot is unable to maintain a reference with the surface, these illusions can bring on spatial disorientation, which can lead to improper flight control inputs and result in a loss of control. The strength of these illusions can be so intense that, especially for pilots with limited flight and instrument experience, even a conscious cross-reference to flight instruments may be insufficient to prompt the pilot to apply the appropriate corrective input to the flight controls.

Not recognizing spatial disorientation immediately may lead to loss of control of the aircraft or to controlled flight into terrain. Several published studies and TSB investigation reports[38] have addressed the phenomenon of spatial disorientation and its consequences.

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36 Bureau of Air Safety Investigation (former name of the Australian Transport Safety Bureau), SAB/RP/95/01, *Dark Night Take-off Accidents in Australia* (April 1995), p.8.

37 Bureau of Air Safety Investigation (former name of the Australian Transport Safety Bureau), SAB/RP/95/01, *Dark Night Take-off Accidents in Australia* (April 1995), p. 8.

38 TSB air transportation safety investigation reports A94H0001, A97P0207, A09O0171, A10P0244, A10Q0132, A11H0001, A11P0106, A11Q0168, A11W0152, A12P0070, A12P0079, A13C0014, A13C0073, A13H0001, A14A0067, A15O0031, A15O0188, A15P0081, A15P0217, A16P0180, A16P0186, A17O0209, A18Q0016, A19O0026, A19W0015, A19O0178.

Shortly after losing sight of the occurrence aircraft, the pilot of the other Cargair aircraft reported experiencing spatial disorientation after entering IMC, resulting in a loss of control of the aircraft. However, she recovered in time to avoid a collision with the ground and was able to return to CYMX.

1.19 Useful or effective investigation techniques

Not applicable.

2.0 ANALYSIS

2.1 Introduction

The pilot held a private pilot licence and a valid Category 3 medical certificate. At the time of the occurrence, the pilot had met the requirements to apply for a night rating endorsement; however, her licence had not yet been endorsed. The flight instructor approved the solo night visual flight rules (VFR) flight departing Montréal International (Mirabel) Airport (CYMX). There were no indications that the pilot's performance was degraded by fatigue.

Examination of the wreckage and the aircraft's technical records did not reveal any mechanical problems that would have played a role in this occurrence, either before or at the time of the accident. Marks found on the trees, damage to the propeller, and instrument analysis data are consistent with the engine producing power at the time of the impact.

The analysis will therefore focus on flight planning and flight instructor supervision, in-flight decision making, including continuing VFR flight into instrument meteorological conditions (IMC), the occurrence pilot's limited experience with night VFR flight, spatial disorientation, and night flight regulations.

2.2 Flight planning and flight instructor supervision

The occurrence pilot had obtained the weather for the flight-planned route on the internet. The pilot and the instructor discussed the cross-country flight to Sherbrooke Airport (CYSC) and the weather conditions that prevailed that evening. They assessed the forecast ceiling and visibility for the route as acceptable for the VFR night flight; however, some concerns were raised about the prevailing winds when the aircraft was expected to reach CYSC. It was agreed that if the winds were too strong, the pilot would not attempt to land. The chief flight instructor was then consulted before the flight was authorized. Although there were concerns regarding the winds, when the plan for the night flight was reviewed by the flight instructor, the ceiling and visibility detailed in the aerodrome routine meteorological reports (METARs) and aerodrome forecasts (TAFs) were assessed as acceptable, and the training flight was authorized.

Cloud ceilings reported in the METARs and TAFs were mainly VFR. However, both of the graphic area forecasts (GFA) relevant for the time period indicated that, in the vicinity of, and behind the cold front, broken ceilings at 3000 feet above sea level (ASL), which was below the planned flight altitude of 3500 feet ASL, could be expected. Additionally, local or patchy ceilings of 1500 feet above ground level (AGL) were forecast. This information was available to the flight instructor and pilot while reviewing the weather. The investigation could not determine which GFA, if any, was reviewed prior to the flight.

If a pre-flight weather review does not include all available information or does not assess the weather's effect on the ability to maintain visual reference to the surface throughout a flight, especially for a planned night flight, there is an increased risk of encountering adverse weather or IMC.

2.3 In-flight decision making

Pilots flying VFR can inadvertently enter IMC; this is especially true at night, when it is more difficult to observe a deterioration in weather conditions and take the necessary measures to avoid the worsening conditions. Pre-flight planning reduces the potential for in-flight decision errors because it can help prepare the pilot for situations that may arise during the flight. Not carrying out this planning can result in decisions being made when the pilot is under a considerable amount of stress, and increases the likelihood of poor or incorrect decision making.

Before takeoff, pilots should develop a plan for what they will do if the weather enroute is different from what they expected or if the weather deteriorates. This plan should consider a requirement to divert or turn back before entering IMC.

The tendency to stick to the initial plan, referred to as plan continuation bias, is an unconscious cognitive bias that involves continuing with an initial plan of action despite changing conditions. Once a plan is made and committed to, it can become increasingly difficult for the individual involved, especially during periods of high workload, to recognize stimuli or conditions that suggest a need to alter the plan.

2.3.1 Continuing visual flight rules flight into instrument meteorological conditions

After the occurrence aircraft levelled off at its cruise altitude of 3500 feet ASL, as filed in the flight plan, it remained at that altitude for approximately 23 minutes. Approximately 32 nautical miles (NM) northwest of CYSC, the occurrence pilot and the pilot of the other Cargair aircraft lost visual reference to the surface and both aircraft descended to 3000 feet ASL to continue the flight towards CYSC. This descent to regain visual reference, and then to remain clear of cloud, was the first indication that the weather ahead may be deteriorating.

After entering IMC for the first time, the pilot was likely affected by an unconscious cognitive bias and her proximity to CYSC, which led her to continue the VFR flight into deteriorating weather conditions.

At this time, in the area surrounding CYSC, cloud layers varied greatly, as evidenced by the 4 aerodrome special meteorological reports (SPECIs) issued between 2100 and 2200. At 2112, scattered cloud layers as low as 2100 feet above ground level (AGL) (approximately 2900 feet ASL) were recorded at CYSC.

Shortly after levelling off at 3000 feet ASL, approximately 19 NM northwest of CYSC, the pilot of the other Cargair aircraft reported losing sight of the occurrence aircraft before encountering IMC herself for a second time, and losing visual references with the ground. Because cloud bases in the area were lower than the occurrence aircraft's altitude, and visual contact with the aircraft was lost, it was determined that as the occurrence aircraft neared CYSC, the pilot inadvertently encountered IMC for a second time, which resulted in a loss of visual reference to the surface.

2.4 Limited experience with night visual flight rules flight

Night flight requires pilots to develop additional skills so they can operate in an environment that is different from that of daytime flight. To compensate for the reduced visual acuity, which is the main source of information to maintain spatial orientation, pilots must refer more frequently to their flight instruments. This skill is initially acquired through training, and maintained through practice.

Although the regulations require pilots to complete a minimum number of hours of night flight and instrument flight before applying to add a night rating to their pilot licence, they are not required, during this training, to receive ground training on the specifics of night flight, such as spatial disorientation, optical and sensory illusions, night vision, human factors, and pilot decision making. The pilot's exposure to these topics is left to the instructor delivering the training. None of the information collected made it possible for the investigation to determine whether the pilot had acquired theoretical knowledge on the specifics of night flight during her night flight training.

2.5 Spatial disorientation

When weather conditions deteriorate, the associated risks must be properly managed at the same time as pilot workload increases. Furthermore, pilots must be able to recognize when conditions are no longer favourable to continue flight and take decisive action. All of this is more difficult for a pilot with limited experience.

Unexpected VFR flight into IMC requires a quick transition to instrument flight to maintain control of the aircraft. Once pilots in this situation become aware of what is happening, their stress level tends to rise rapidly. Pilots are typically able to maintain control of an aircraft without adequate visual cues for about 60 seconds if the aircraft is in straight and level flight at the time visual cues are lost. If the aircraft is in a turn, this amount of time is even shorter. Pilots with limited knowledge of, and practice with, instrument flight run the risk of making inappropriate manoeuvres and control inputs and can become spatially disoriented.

In the moments before the occurrence, the pilot likely initiated a course reversal in an attempt to continue flying under VFR after entering IMC a second time. For a non-instrument-rated pilot relying solely on visual references to the ground, whether during the day or at night, even with basic attitude instrument flying proficiency the unplanned loss of all external visual references is a critical situation, and a loss of aircraft control can occur quickly. The other Cargair aircraft reported experiencing spatial disorientation after entering IMC, resulting in a loss of control of the aircraft. However, she recovered in time to avoid a collision with the ground and was able to return to CYMX.

Given the established correlation between loss of visual references and a loss of control, it is highly likely that the pilot, who had limited experience flying by sole reference to instruments, lost control of the aircraft as a result of spatial disorientation.

2.6 Night flight regulations

A flight flown during the day does not have the same characteristics as when it is flown at night. During a night flight, given the darkness, it can be difficult or even impossible to perceive deteriorating weather conditions. If visibility is good, well-lit areas may compensate for areas with less lighting. However, if visibility deteriorates to the point where the pilot is unable to see beyond an area with little ground lighting, the risk of losing reference to the surface increases. Therefore, when planning a night VFR flight, it is preferable that the flight path be determined in consideration of those areas that provide the most ground lighting possible, and not necessarily flown in a straight line.

Pilots flying under VFR must maintain visual reference to the surface, regardless of whether the flight is conducted in daylight or darkness. The *Canadian Aviation Regulations* (CARs) stipulate that all night VFR flights, whether conducted in controlled or uncontrolled airspace, be "operated with visual reference to the surface." However, what the term "visual reference to the surface" means is open to interpretation, as the concept is not defined in the regulations.

In 2016, the TSB issued Recommendation A16-08 concerning the lack of clarity in the practical meaning of "flight with visual references to the surface." Transport Canada is in the process of drafting 2 notices of proposed amendment that will lead to updating the night VFR requirements. However, until the details of the proposed regulatory amendments are fully known, the TSB cannot evaluate whether these measures will fully address the risks associated with night VFR flights.

If the CARs do not clearly define what is meant by "visual reference to the surface," night flights may be conducted with inadequate visual references, which increases the risks associated with night VFR flight, including controlled-flight-into-terrain and loss-of-control accidents.

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. When the plan for the night flight was reviewed by the flight instructor, the ceiling and visibility detailed in the aerodrome routine meteorological reports and aerodrome forecasts were assessed as acceptable, and the training flight was authorized.

2. After entering instrument meteorological conditions for the first time, the pilot was likely affected by an unconscious cognitive bias and her proximity to Sherbrooke Airport, Quebec, which led her to continue the visual flight rules flight into deteriorating weather conditions.

3. As the occurrence aircraft neared Sherbrooke Airport, the pilot inadvertently encountered instrument meteorological conditions for a second time, which resulted in a loss of visual reference to the surface.

4. Given the established correlation between loss of visual references and a loss of control, it is highly likely that the pilot, who had limited experience flying by sole reference to instruments, lost control of the aircraft as a result of spatial disorientation.

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 a pre-flight weather review does not include all available information or does not assess the weather's effect on the ability to maintain visual reference to the surface throughout a flight, especially for a planned night flight, there is an increased risk of encountering adverse weather or instrument meteorological conditions.

2. If the *Canadian Aviation Regulations* do not clearly define what is meant by "visual reference to the surface," night flights may be conducted with inadequate visual references, which increases the risks associated with night visual flight rules flight, including controlled-flight-into-terrain and loss-of-control accidents.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 Cargair Ltd.

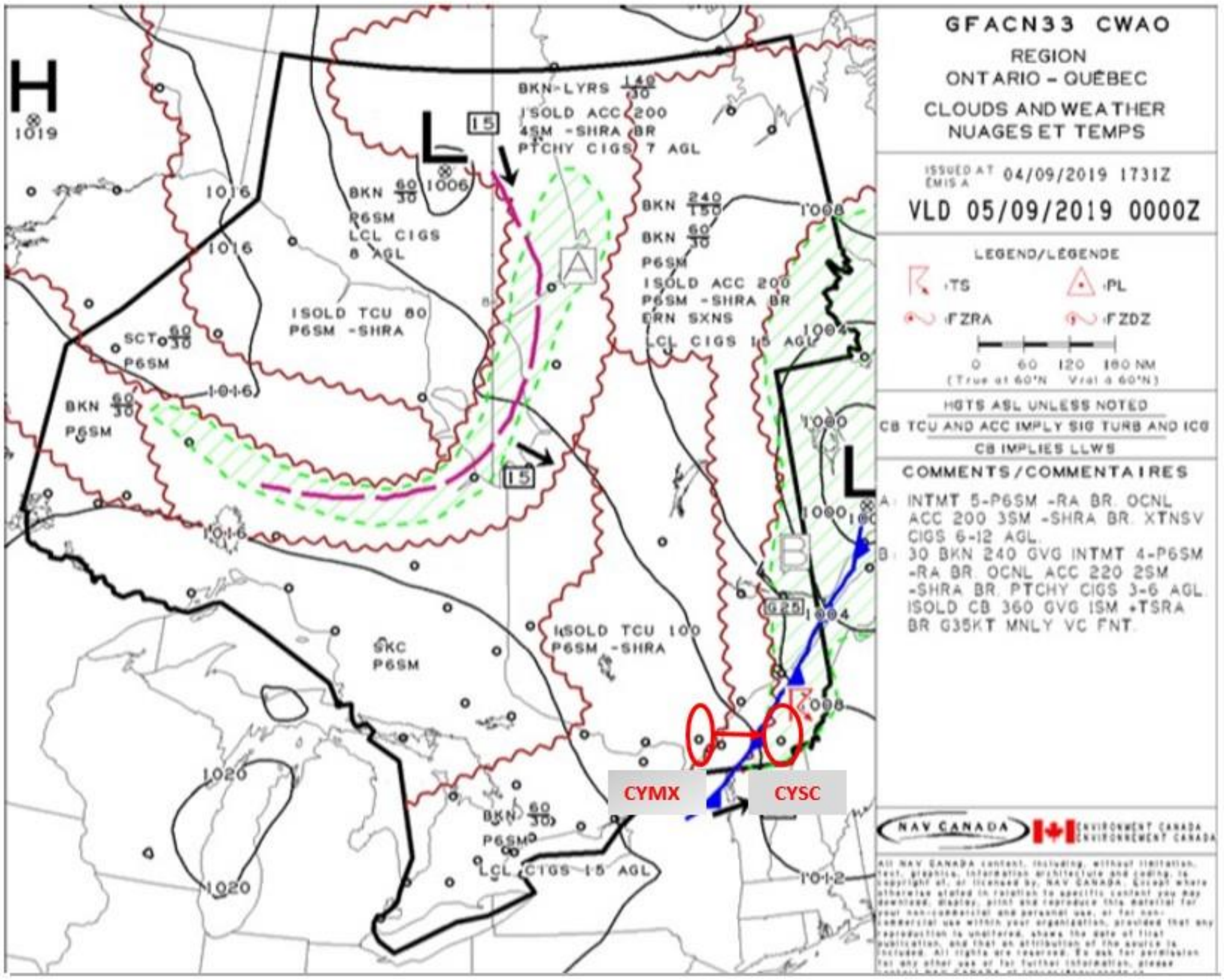
The following risk mitigation measures were put in place by Cargair Ltd. after this occurrence:

- The list of airports authorized for dual and solo night flights has been revised.
- Restrictions on solo night flights have been put in place for both licenced and non-licenced pilots training at Cargair.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 10 March 2021. It was officially released on 23 March 2021.

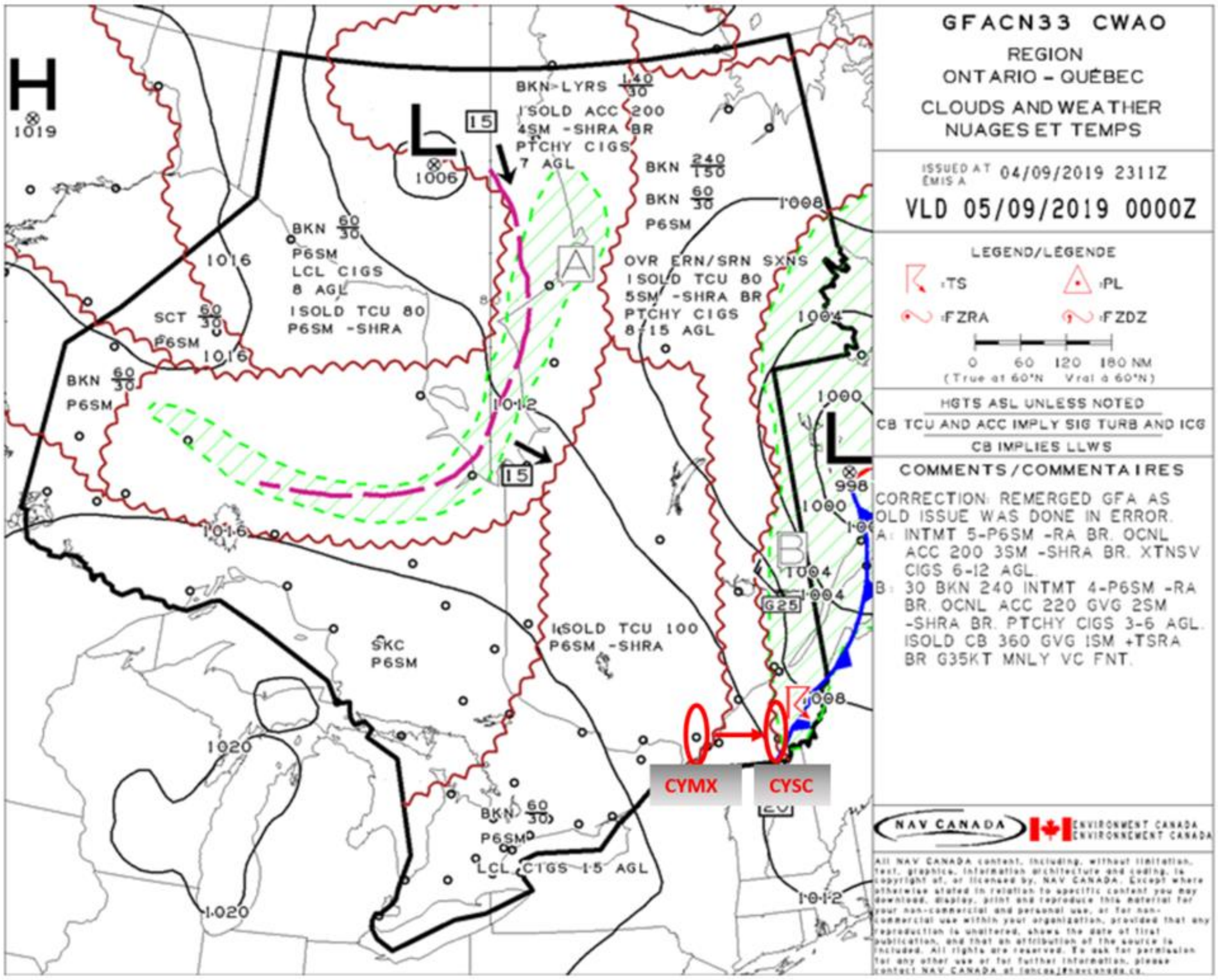
APPENDICES

Appendix A – Graphic Area Forecast (GFA) Clouds and Weather Chart – GFACN33 issued at 1331 Eastern Daylight Time



Source: NAV CANADA, with TSB annotations.

Appendix B – Graphic Area Forecast (GFA) Clouds and Weather Chart – GFACN33 issued at 1911 Eastern Daylight Time



Source: NAV CANADA, with TSB annotations.