AVIATION OCCURRENCE REPORT
A97Q0158

IN-FLIGHT BREAK-UP

CESSNA 210F C-FSEX

MILAN, QUEBEC

28 JULY 1997

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Summary

The pilot of the Cessna 210F, serial number 21058753, with his wife and three children on board, was on an instrument flight rules (IFR) travel flight from Cornwall, Ontario, to Charlottetown, Prince Edward Island. At 1626, eastern daylight saving time, in level flight at 9000 feet above sea level (asl), the pilot advised the controller that he was about to enter rain showers. At 1636 the aircraft disappeared from the controller's radar screen in an area of significant weather returns. The aircraft broke up in flight in a thunderstorm. Search and Rescue services found the aircraft five hours later. The Cessna was destroyed; the five occupants perished in the accident.

Ce rapport est également disponible en français.

Other Factual Information

The pilot, who was employed by an airline, held a valid airline pilot licence and a Group 1 instrument flight rating. He had flown several types of single-engine and multi-engine aircraft; he had over 5000 flying hours, including 1300 hours under instrument flight rules (IFR). His employer considered him to be a safe pilot who did not hesitate to postpone or cancel a trip when he considered the weather unfavourable for a flight. The pilot had completed the Transport Canada company air safety officer course.

The pilot had rented a house on Prince Edward Island for a one-week family vacation starting 28 July 1997. He was to travel there in his private aircraft. At 0010 eastern daylight saving time (EDT) on the day of the accident, the pilot received weather information for the flight from the London, Ontario Flight Service Station (FSS). A pressure trough was located north of New York State. Thunderstorms were forecast for the London area between 0200 and 0800. The storms were associated with a cold front extending from south of James Bay to north of Lake Huron. The frontal system, which was tracking east-southeast at 25 knots, was moving ahead of the flight along the pilot's intended route. The pilot correctly calculated that he would catch up with the cold front at Cornwall and be clear of it around Sherbrooke, Quebec. He also estimated that he would fly through the storm area south of Montreal, Quebec.

The pilot was hoping to reach Charlottetown before sunset; he therefore planned to take off from Tillsonburg Airport, Ontario, where his aircraft was parked, around 0900. At the airport, while preparing for the flight, the pilot told an attendant that he was anxious to depart, as he was already running late. However, it was only around 1230 that he took off for Charlottetown with stops planned at Brantford, Ontario, and Cornwall. The short flight to Brantford was without incident; on the ground the pilot had the aircraft's tires inflated and he borrowed some IFR charts. He seemed rested and fit, and especially glad to be going on vacation. He took off around 1300 for Cornwall to refuel.

At 1435, 35 minutes before landing at Cornwall, the pilot called the FSS specialist at Gatineau, Quebec, to advise that he planned to take off IFR from Cornwall around 1600 and to request en route weather. Visual meteorological conditions (VMC) were forecast for Charlottetown at 1600. Next, the specialist specifically mentioned that an area of active thunderstorms was over Montreal and vicinity and that a significant meteorological message (SIGMET) was issued at 1321 for the storm area. A SIGMET is issued only for the most dangerous phenomena of vital importance to aircraft of all types. The specialist transmitted to the pilot the following information from the SIGMET C2:

> Thunderstorms were observed by weather radar and satellite photo on a line from 30 miles east of Québec to Trois-Rivières to 30 miles north of Montreal to 20 miles northeast of Ottawa. The maximum summit of the storm line is estimated at 40,000 feet causing visibility of two to five miles, thunderstorms and heavy rain showers, and a risk of hail and local gusting to 50 knots. Icing and severe turbulence are associated with the storm line. The storm line is moving east at 35 knots and gaining in intensity until 2015 UTC.

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[1] All times are EDT (coordinated universal time [UTC] minus four hours), unless otherwise stated.

The specialist also reported that the storm line extended along the St. Lawrence River and heavy rain showers could be expected in the vicinity. He also read the following weather observation in effect at Dorval: winds from 310 degrees magnetic at 26 knots gusting to 44 knots, visibility one mile, moderate rain showers, storms and cloud layer at 100 feet broken. The pilot replied that he did not anticipate any problems because, according to him, the storm line was just north of his route.

After landing at Cornwall, the pilot refuelled and filed an IFR flight plan for the final eastbound leg. Shortly after take-off, just before making and maintaining radio contact with the Montreal centre, the aircraft appeared on the radar screen at Montreal terminal at 1545. The controller first instructed the pilot to proceed on heading 075 degrees magnetic at 9000 feet asl to keep the aircraft to the north of some significant weather returns displayed on his screen. He then told him that he would be radar vectored to his destination because the route indicated on the flight plan ran right through an area of adverse weather.

The controller also advised the pilot to expect heavy weather, rain and storms all the way to near Millinocket, Maine, USA, and that the adverse weather over the St. Lawrence River had moved south of Montreal. The pilot then decided to divert to the north of the weather system instead of to the south as he had intended previously.

At 1604, about eight nautical miles west of Saint-Jean Airport, Quebec, radar vectoring terminated and normal navigation was resumed. The controller suggested to the pilot, given the position of the weather system, that he divert much farther to the north to get around the storm line. At 1607 the controller for the Granby, Quebec sector took charge of the flight. Between 1607 and 1613, the pilot modified his route three times due to adverse weather:

- At 1607 the pilot decided to head directly for the VHF omnirange at Sherbrooke, Quebec.

- At 1611 he requested to divert north to the VOR at Beauce, Quebec to avoid the weather.

- At 1613 he opted to head directly for Charlottetown: the controller had just advised him that, based on the radar sweep, the weather was more favourable to the east and toward Charlottetown than around the Beauce VOR. The controller also told the pilot he should be clear of the weather after Sherbrooke.

Subsequently, the controller gave the pilot some information on the locations of areas of heavy precipitation. The controller's duties include helping aircraft to avoid weather by advising them of alternate routes and providing information concerning very adverse weather conditions like SIGMETs to all aircraft in or about to enter the area. To accomplish this, the controller uses, among other things, air traffic services (ATS) radars and the Operational Information Display System (OIDS). However, data from weather radars and satellite photos cannot be displayed at the controller's workstation because no monitor is provided for that purpose.

The radars at Québec and Montreal, which provide data to the controller, showed a line of significant weather returns extending from Québec to south of Montreal. The line appeared to be unbroken except for a gap over the Sherbrooke area. The ATS radar indicated that the aircraft was headed toward the gap on a track that seemed largely free of weather returns. In fact, the pilot was about to fly through heavy rain that was not shown on the controller's screen. Satellite photos and the Villeroy weather radar data for 1630 indicated several areas of heavy precipitation in the Sherbrooke area that had not been detected by the ATS radars.

The *Aeronautical Information Publication* (A.I.P. Canada) states that ATS radar, due to its inherent limitations, cannot always detect weather disturbances. A storm cell can be concealed if it is behind other radar contacts. In fact, during the flight, at the request of the controller, the pilot had to describe the weather he saw in front of him. Also, neither ATS radars nor weather radars can see turbulence.

At 1626 the pilot reported that he was "plowing through" some rain showers, even though it did not seem very safe to him. He also confirmed that he would continue the flight to Charlottetown. That was the last message received from the pilot. At that time the aircraft was in level flight at 9000 feet asl and a ground speed of 190 knots, and was 10 nautical miles south of the weather line observed by ATS radar. Abeam of the Sherbrooke VOR, about seven minutes before the in-flight break-up, the pilot made three heading corrections and headed toward an area of weather returns, where the aircraft disappeared from the radar screen at 1636.

Radar data obtained from ATS revealed that in the area of the Sherbrooke VOR, the changes in the aircraft's altitude had increased in frequency and scale; the vertical speed of the aircraft was fluctuating widely, with a climb rate often exceeding 600 feet per minute. The last returns indicated that the aircraft had climbed to 9400 feet asl when it started to lose altitude rapidly; its rate of descent reached 6000 feet per minute at an altitude of 7700 feet asl when its transponder ceased responding. Data from the Villeroy weather radar indicated that the aircraft was in an area of heavy precipitation when the break-up occurred. The A.I.P. Canada states that the intensity of turbulence is in proportion to the amount of rain that accompanies it. Severe turbulence like that reported in SIGMET C2 produces significant and sudden changes in altitude and/or attitude. It can also cause wide variations in indicated speed. The pilot might even lose control of the aircraft momentarily.

The dangers involved in operating near storms are known and extensively documented in several aeronautical publications. Section 2.7 of chapter AIR of the A.I.P. Canada deals with operations near thunderstorms: "the visible thunderstorm cloud is only a portion of a turbulent system of updrafts and downdrafts that often extend far beyond. Severe turbulence may extend up to 20 NM from severe thunderstorms. [...] No flight path, through an area of strong or very strong radar echos separated by 40 NM or less, can be considered free of severe turbulence".

After the SIGMET C2 was issued, the Montreal forecast centre issued two consecutive SIGMETs for the Montreal and Québec areas that were not relayed to the pilot. SIGMET C3 issued at 1501 to replace C2, and SIGMET C4, issued at 1553 to replace C3, repositioned the storm line moving east; they included warnings of potential dangers that were essentially the same as those contained in SIGMET C2. The aircraft was in the Cornwall area when these SIGMETs were issued.

The aircraft broke up in flight over a wooded area and came to rest in brush near a logging road, 23 nautical miles east-northeast of the Sherbrooke VOR. Pieces of wreckage were scattered on both sides of the break-up trajectory, which was on a heading of 356 degrees magnetic. Although several pieces were spread over a distance of 2250 feet, the largest pieces were found in two main areas. The cabin and the left wing and stabilizer were found as one unit. The engine separated from the airframe after striking the ground. The flaps and landing gear were retracted. All engine cowls and doors were found at the point of impact. The right wing, fin and right horizontal stabilizer separated from the fuselage before the aircraft struck the ground. The right wing strut and part of the right wing skin were found about 2250 feet from the main point of impact, and the right horizontal stabilizer, fin and right wing were found about 500 feet farther north.

After the wreckage was examined at the accident site, it was transported to the Saint-Mathias Airport, Quebec, for further examination. The analysis of the aircraft was carried out by the TSB Engineering Branch. Examination of the flight control systems revealed no evidence of loss of continuity prior to the aircraft break-up. Both wings were partly shredded and showed similar deformations. They exhibited the effects of upward bending and rearward torsional moments. These substantial damages occurred in flight. Failure analysis suggests that the right wing fractured first, just inboard of the strut joint, then the wing struck the fin and the right horizontal stabilizer, which then failed.

There was no indication of a fire on board the aircraft or of a fuel tank explosion. The doors and cowls were attached to the fuselage at the time of ground impact. There was no indication of flutter or aeronautical flutter on the flight control surfaces. No signs of metal fatigue were observed. Examination of the debris revealed that all fractures were caused by either instantaneous overload or tearing.

There is every indication that the engine was serviceable and capable of producing power. Examination of the propeller revealed no pre-impact deficiencies that would have prevented it from operating normally.

The aircraft, which the pilot owned, was found airworthy on 05 June 1997 following an annual inspection. C-FSEX was certified, equipped and maintained in accordance with existing regulations and approved procedures. The available information indicates that the aircraft had approximately 2830 hours. The weight and centre of gravity were within the prescribed limits. The aircraft weight at the time of the accident was estimated at 2965 lb. Its service ceiling or maximum certified flight altitude was 19 900 feet. The aircraft was equipped for instrument flight. C-FSEX was also equipped with a global positioning system (GPS). It was not equipped with weather radar or a Stormscope storm detector; these instruments were not mandatory on this aircraft. Weather radar is often the most effective means of avoiding adverse weather during IFR flight. The pilot did not report any deficiencies or problems with the aircraft during the flight.

Based on the autopsy, toxicology and medical records, there was no indication that incapacitation or physiological factors affected the pilot's performance.

Analysis

Examination of the debris revealed no signs of fatigue or flutter. Also, the wreckage analysis determined that all fractures resulted from instantaneous overload. The available information suggests that the aircraft broke up in flight after entering a heavy rain shower, and that the turbulence normally associated with that weather phenomenon led to aerodynamic overloading of the wings.

Prior to take-off, the pilot obtained a full weather report as part of his flight planning. The weather prognosis, area forecasts, SIGMET C2 and specific reports on the locations of the areas of heavy precipitation were fairly representative of the conditions prevailing en route. Based on this information, supplied by FSS specialists and ATS controllers, the pilot would have been able to conclude that he would have to cross a cold front and a storm line to get to Charlottetown.

As the holder of an airline pilot licence and instrument rating, the pilot had the ability, knowledge and experience to recognize the dangers associated with flying near thunderstorms. By correctly calculating the movement of the cold front and where he would catch up with it, the pilot demonstrated that he clearly understood the weather system. Since the pilot could neither fly over the storm line, as he was limited to an altitude of 19 900 feet, nor fly around it, as it extended too far north-to-south, it would have been appropriate to wait on the ground until conditions improved. The investigation did not reveal why the pilot decided to take off from Cornwall and attempt to fly through adverse weather in an aircraft with no weather radar or a Stormscope storm detector. It was determined that there were no operational factors compelling him to continue the flight, since he had enough reserve fuel to wait or divert to another airport.

The ATS controllers performed their duties in accordance with established procedures and their assigned responsibilities. They provided radar vectoring to help the pilot avoid adverse weather and transmitted relevant meteorological information, except SIGMETs C3 and C4. As a result, the influence that these two SIGMETs might have had on the pilot's decision to continue the flight could not be evaluated. However, the pilot was aware of the dangers associated with the cold front because before arriving at Cornwall he had received SIGMET C2, which was essentially similar to C3 and C4. The investigation did not determine why the pilot was not advised of these SIGMETs or whether the controllers were advised on OIDS. Also, nine minutes before the crash, the Granby sector controller, acting in accordance with the rules, advised the pilot that the weather straight ahead appeared favourable, while in fact the aircraft was heading toward heavy showers. A specific display of the meteorological conditions was not available to the controller. The controller was therefore unaware of the areas of heavy precipitation because he did not have the equipment needed to display data from the Villeroy weather radar. Consequently, the controller did not have the information or tools required to accurately inform the pilot of safer alternate routes.

Although it could not be determined why the pilot initiated and continued the flight, his decision may have been influenced by several factors. His and his family's apparent desire to land at Charlottetown before dusk on the first day of their one-week house rental may have caused him to take risks. The pilot may have overestimated the capabilities of ATS radar and the information provided by the controller on the position and movement of the areas of heavy precipitation. Still, the pilot must have been at least somewhat aware of the limitations of the radar system because the controller occasionally had asked him to describe the weather he observed in front of him. In any case, the pilot was entirely responsible for the aircraft, and he tried to squeeze between the storms despite the risks that he had recognized. He apparently made that decision in order to reach his destination by evading the storms. Whether he did not fully appreciate the limitations of the radar system or

he did not have adequate meteorological information, the pilot did have sufficient information to determine that the weather near the cold front was hazardous, especially for an aircraft with no storm detection instruments. Moreover, the pilot must have known that the information provided by the radar controller was provided on an advisory basis and could be inaccurate, especially near areas of storm activity.

After penetrating the storm line, the pilot must have decided to maintain heading to get through as quickly as possible and avoid turns so he would not increase structural stresses on the aircraft.

The following laboratory report was completed:

LP 128/97 - Examination of Aircraft Structure In-flight Break-up.

Findings

1. The pilot was certified, trained and qualified for the flight in accordance with existing regulations.

2. Based on the autopsy and toxicology records, there was no indication that incapacitation or physiological factors affected the pilots's performance.

3. The pilot knew that to reach his destination that day he had to go through heavy weather, rain and a thunderstorm area.

4. The aircraft was not equipped with weather radar or a Stormscope storm detector.

5. Approximately 10 minutes before the crash, the pilot reported that he was "plowing through" rain showers, although it did not seem very safe to him.

6. The aircraft broke up in flight as a result of penetrating an area of severe turbulence and heavy precipitation.

Causes and Contributing Factors

The aircraft broke up after the pilot attempted to fly through a storm line. The pilot's and his family's eagerness to start their vacation and the pilot's overestimation of the ability of ATS radar to detect areas of heavy precipitation likely contributed to the accident.

Safety Action Taken

En Route Weather

Transport Canada, in order to increase pilot awareness of Air Traffic Control limitations in providing current en route weather, will include additional questions in this area on the instrument rating and Airline Transport Pilot Licence written examinations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 12 August 1999.