Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A99P0108

MIDAIR COLLISION

BETWEEN
CESSNA 177RG CARDINAL C-GWYY
AND
MOONEY M20C C-GASL
PENTICTON, BRITISH COLUMBIA
20 AUGUST 1999

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

Midair Collision

Between
Cessna 177RG Cardinal C-GWYY
and
Mooney M20C C-GASL
Penticton, British Columbia
20 August 1999

Report Number A99P0108

Synopsis

A Mooney M20C was returning to the Penticton, British Columbia, airport from the northwest after a local visual flight rules flight with the pilot and three passengers on board. The aircraft remained west of the extended runway 34 centreline until turning eastbound onto a track that would intersect the departure path of runway 34. About this time, a Cessna 177RG at the Penticton airport taxied out for a visual flight rules departure, northbound to Valemount, with only the pilot on board. The pilot of the Cessna 177RG advised the Penticton flight service station that he was ready to depart. The flight service station specialist acknowledged and recorded the departure time as 1135 Pacific daylight time. At about 1136, the Cessna 177RG and the Mooney M20C collided in-flight about 0.9 nautical mile from the departure end of runway 34. Both aircraft were destroyed and crashed within the city of Penticton. All five occupants were fatally injured; no other injuries occurred. At the time of the accident, the weather was sunny with unrestricted visibility, little cloud, and calm wind.

Ce rapport est également disponible en français.

Figures

1.0 Factual Information

1.1 History of Flight

1.1.1 Mooney M20C

The Mooney M20C, hereafter called "the Mooney", departed the Penticton, British Columbia, airport from runway 16 at 1052 Pacific daylight time (PDT)[1] on a local visual flight rules (VFR) sightseeing flight and was expected to return in about 45 minutes.

At 1127, the pilot re-established communications with the Penticton flight service station (FSS) on the mandatory frequency (MF) of 118.5 megahertz and reported that he was east of the airport at 5500 feet inbound for landing. The Penticton FSS issued an airport advisory indicating that runway 34 was the preferred runway. The pilot acknowledged runway 34. At 1130, he advised that he was proceeding northwest toward Naramata—8 nautical miles (nm) north of the airport—for his descent. At 1133, the pilot reported by Naramata. About one minute later, he advised that he was proceeding south along the west side of Okanagan Lake toward Penticton. The initial contact was the only time the pilot reported his altitude to the FSS.

The West Bench section of Penticton is within the Penticton MF area, on the west hillside of the Okanagan valley, facing east and overlooking the city.

As the aircraft flew south along the west shoreline, witnesses reported that it flew by the Redwing subdivision and the West Bench area at a low altitude, close enough for people on the ground to see the people inside. A witness viewed the aircraft from the east and described the flight profile to be below the level of a landmark on the hillside. The landmark is about 400 feet above the elevation of the airport. Near the southwest corner of Okanagan Lake, abeam the West Bench area, the aircraft entered a left turn. This turn took the aircraft on a southeasterly heading parallel to and north of a section of the canal that passes through the city and connects Okanagan Lake with Skaha Lake on the south side of Penticton. On this heading, the flight path intersected the departure path of runway 34, close to the Penticton non-directional beacon (NDB).

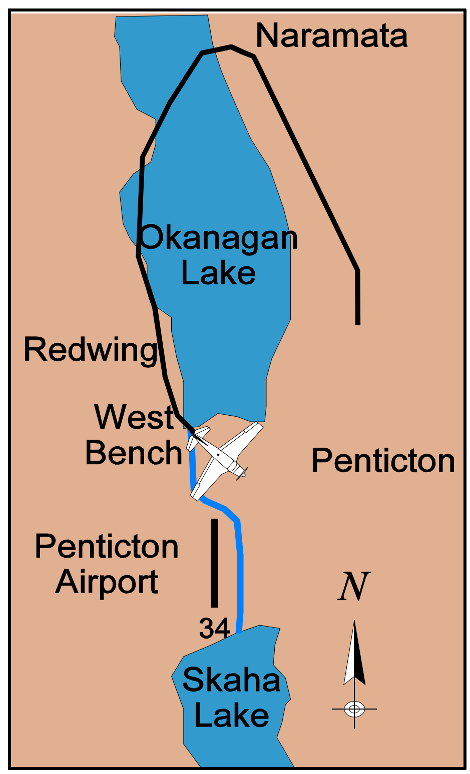

Figure 1 – Mooney M20C flight path

1 All times are PDT (Coordinated Universal Time minus seven hours). See Appendix A—Glossary for abbreviations and acronyms.

1.1.2 *Cessna 177RG*

The pilot of the Cessna 177RG, hereafter called "the Cessna", had filed a flight plan with the Penticton FSS for a VFR flight north to Valemount for one person on board. The flight plan included an estimated time en route of 1 hour 45 minutes and 4.5 hours of fuel duration. An altitude was not specified.

At 1129, the pilot called the Penticton FSS on the MF and advised that he was taxiing out at Penticton for a northbound departure to Valemount on a VFR flight plan. The Penticton FSS issued an airport advisory indicating that two aeroplanes (including the Mooney) were inbound for landing on runway 34 and that one helicopter was inbound for a helipad. The pilot acknowledged the advisory and proceeded to taxi.

At 1134, after the helicopter and one of the two aeroplanes had landed, the pilot of the Cessna called the Penticton FSS on the MF and advised that he was ready for take-off on runway 34. The pilot did not request a traffic update. The FSS acknowledged the transmission, and the Cessna departed at 1135.

1.1.3 *Penticton Flight Service Station*

An FSS is a ground station established to provide air traffic advisory services, flight information services, and emergency assistance services for the safe movement of aircraft. The FSS specialist is not an air traffic controller and is not responsible for air traffic separation. The Penticton FSS uses the former air traffic control tower, which provides the specialists a clear view of the airport and the surrounding area in all directions. Three operational FSS specialists were on duty at the time of the accident. Two specialists were in the cab: one staffing the Radio position and one staffing the Support position. The third specialist was staffing the Downstairs position in the main FSS office.

Communication records show that the Penticton FSS had communicated with four aircraft on the MF and with an airport staff vehicle on the ground control frequency in the 11 minutes before the accident. In the 2 to 3 minutes before the accident, the only communications were with the two accident aircraft on the MF; there were no communications on the ground control frequency. At the time of the collision, one operations-related telephone call was in progress between the Support position and the Downstairs position. Both specialists in the cab reported their workload to be light during the 30 minutes before the collision.

When the Cessna taxied for departure, the pilot was advised of and acknowledged three aircraft inbound to the airport. During the next five minutes, the Penticton FSS received five transmissions from the inbound Mooney and replied three times before the Cessna departed. The pilot of the departing Cessna did not request a traffic update, nor was he directly advised of the one remaining aircraft inbound from the northwest (the Mooney). The FSS specialist did not make a direct transmission to the arriving Mooney to advise of the Cessna departing from runway 34 or to request a position update and circuit-joining intentions to determine if a conflict might exist; the *Flight Service Station Manual of Operations* (FSS MANOPS) does not require these actions if the FSS operator believes there are no conflicts. Because both pilots were, or should have been, operating on the same frequency, they should have been aware of the other's position and intentions. No other traffic was reported in the Penticton MF area at the time.

1.2 *Injuries to Persons*

1.2.1 *Mooney M20C*

	Crew	Passengers	Total
Fatal	1	3	4
Serious	-	-	-
Minor/None	-	-	-
Total	1	3	4

1.2.2 *Cessna 177RG*

	Crew	Passengers	Total
Fatal	1	-	1
Serious	-	-	-
Minor/None	-	-	-
Total	1	-	1

1.3 *Damage to Aircraft*

No indication was found of a malfunction or pre-existing mechanical defect in either aircraft. Both aircraft apparently followed their respective flight paths and profiles in a controlled fashion until the in-flight collision. The departing Cessna was seen to be climbing normally following the extended runway centreline, and the Mooney was seen flying at low level in a smooth left-hand turn in the seconds before the in-flight collision. After the aircraft collided, the damage rendered both aircraft uncontrollable.

1.3.1 Mooney M20C

The right wing, outboard of the main landing gear, and the vertical stabilizer were severed from the aircraft. Both pieces struck the ground within a fenced area at the city waste treatment plant located on a bearing of 162 degrees magnetic (°M), 1330 feet from the Penticton NDB tower. The body of the aircraft struck the ground in a factory work yard located on a bearing of 132°M, 1970 feet from the Penticton NDB tower and 4580 feet north of the departure end of runway 34. The collision and the ground impact destroyed the aircraft. No fire occurred.

The aircraft journey logs and the aircraft documents had not been on board the aircraft and were obtained, along with the pilot's personal logbook, from his family.

1.3.2 Cessna 177RG

An outboard section of the right wing was severed during the midair collision and struck the ground near the severed wing and vertical stabilizer of the Mooney. The body of the aircraft struck the ground in a vacant parking lot on a bearing of 210°M, 440 feet from the Penticton NDB tower. The aircraft caught fire at impact and was virtually consumed except for the tail section. However, the pilot's personal flight log and the aircraft journey log containing the aircraft documents were recovered intact from the wreckage.

1.4 Other Damage

The two aircraft created small impact craters in the asphalt surface at their respective accident sites. There was some fire damage to the grass field adjacent to the site of the main Cessna wreckage.

1.5 Personnel Information

1.5.1 Mooney M20C

Age	33
Pilot Licence	Commercial restricted to Private Pilot privileges
Medical Expiry Date	01 July 2000
Total Flying Hours	1173
Hours Last 90 Days	59
Hours on Type Last 90 Days	3.2

The pilot had held a Canadian Commercial Pilot Licence—Aeroplane (CPL–A) since 29 July 1987; however, his licence was valid for Private Pilot Licence—Aeroplane (PPL–A) privileges only, because more than 12 months had passed since his last civil aviation medical examination. His licence included a Group 2 instrument rating valid until 01 September 2001. His personal logbook indicated that he had flown 3.2 hours on this particular aircraft within the previous 12 months. His logbook also indicated that he had flown 103 hours on a similar aircraft and 55 hours on a light twin-engine aircraft and that he had completed 6 trips to Penticton within the previous 12 months.

1.5.2 Cessna 177RG

Age	56
Pilot Licence	Private Pilot—Aeroplane
Medical Expiry Date	01 May 2000
Total Flying Hours	568
Hours Last 90 Days	4.6
Hours on Type Last 90 Days	4.6

The pilot held a Canadian PPL–A since 13 December 1981. His licence included a night endorsement obtained 30 October 1994. His personal logbook indicated he had accumulated 362 hours of flight time on this particular aircraft or model since 15 October 1989 and that he had flown 46 hours within the previous 12 months. He was a resident of Penticton from 1983 until 1991, when he relocated to Valemount; however, he continued to fly out of Penticton.

1.5.3 Penticton FSS Specialist—Radio Position

FSS Position	Air/Ground 2 (Radio) Assisted by one other FSS specialist
Qualification	Classification: RO-000-03 FSS specialist
Experience	
- Basic Training	1975
- Worked in the Penticton FSS	since March 1995
- Onsite Unit Qualification	April 1995
- FSS Refresher Training	February 1987, February 1992, August 1997, February 1998, December 1998
Hours on Duty Prior to Incident	5.6
Hours off Duty Prior to Work Period	10.9

This specialist was trained and qualified to work as an operational FSS specialist at the Penticton airport. According to the Penticton FSS shift schedule, he was working his sixth of seven shifts scheduled and had been on duty for 5.6 hours before the accident occurred.

1.5.4 Penticton FSS Specialist—Support Position

FSS Position	Support (provides support to Radio position)
Qualification	Classification: RO-000-03 FSS specialist
Experience	
- Basic Training	1967
- Worked in the Penticton FSS	since March 1995
- Onsite Unit Qualification	May 1995
- FSS Refresher Training	February 1988, January 1992, February 1998, December 1998
Hours on Duty Prior to Incident	1.1
Hours off Duty Prior to Work Period	11.1

This specialist was trained and qualified to work as an operational FSS specialist at the Penticton airport. According to the Penticton FSS shift schedule, he was working his third of six scheduled shifts and had been on duty for 1.1 hours before the accident occurred.

1.5.5 Penticton FSS Specialist—Downstairs Position

The third FSS specialist was working in the main FSS office and was not involved in providing information to the accident aircraft. This position does not normally monitor the MF at Penticton when more than one FSS specialist is on duty and the Radio and Support positions are in operation. He was not monitoring the Penticton MF at the time of this accident.

1.6 Aircraft Information

1.6.1 Mooney M20C

Manufacturer	Mooney Aircraft Company
Type and Model	M20C
Year of Manufacture	1962
Serial Number	2225
Certificate of Airworthiness	21 April 1992
Total Airframe Time	3163 hours
Engine Type (number of)	Avco Lycoming O-360-A1D (1)
Propeller	Hartzell HC-CY2K-1BF
Maximum Allowable Take-off Weight	2575 pounds
Recommended Fuel Type	Avgas 100 LL
Fuel Type Used	Avgas 100 LL

The Mooney is a single-engine, four-place aeroplane capable of cruising flight at 130 knots calibrated airspeed. The aircraft is a conventional configuration with a low wing and retractable tricycle landing gear. Standard equipment includes one fixed landing light mounted on the nose of the aircraft below the propeller hub. Optional wing-tip strobe lights were installed and serviceable. It could not be determined whether any of the external aircraft lights were on at the time of the accident.

The aircraft's wings were red (top and bottom), and the fuselage was red (bottom) and white (top).

The weight and balance of the Mooney at take-off from Penticton was estimated to have been within certificated limits. The aircraft weight was calculated to be approximately 2245 pounds when it taxied out for take-off. The aircraft contained about 110 pounds of fuel (total capacity was 288 pounds), and the pilot and the three passengers weighed an estimated 600 pounds.

An examination of the aircraft and engine maintenance records and other documentation revealed nothing remarkable. The aircraft was certificated, equipped, and maintained in accordance with existing regulations and approved procedures.

1.6.2 Cessna 177RG

Manufacturer	Cessna Aircraft Company
Type and Model	177RG
Year of Manufacture	1976
Serial Number	177RG1101
Certificate of Airworthiness	29 June 1990
Total Airframe Time	2562.7 hours
Engine Type (number of)	Avco Lycoming IO-360-A1B6D (1)
Propeller	McCauley B2D34C207
Maximum Allowable Take-off Weight	2800 pounds
Recommended Fuel Type	Avgas 100 LL, Avgas 100
Fuel Type Used	Avgas 100 LL

The Cessna Cardinal is a four-place, single-engine aircraft capable of cruising flight at 142 knots indicated airspeed. The aircraft is a conventional configuration, with a cantilevered high wing and retractable tricycle landing gear. Standard equipment includes one fixed landing light and one fixed taxi light mounted on the nose of the aircraft, below the propeller hub. Optional wing-tip strobe lights were installed and serviceable. It could not be determined whether any of the external aircraft lights were on at the time of the accident.

The aircraft was predominantly white with red trim.

The weight and balance of the aircraft at take-off from Penticton was estimated to have been within certificated limits. The aircraft weighed an estimated 2275 pounds when it taxied out for take-off. The aircraft contained 200 pounds of fuel and 50 pounds of baggage; the pilot's weight was reported to be 210 pounds.

An examination of the aircraft and engine maintenance records and other documentation revealed nothing remarkable. The aircraft was certificated, equipped, and maintained in accordance with existing regulations and approved procedures.

1.7 Meteorological Information

The Penticton 1100 regular weather observation taken by the Penticton FSS was as follows: wind 140 degrees true (°T) at 2 knots, visibility 15 statute miles or greater, a few clouds at 5500 feet above ground level (agl), a few clouds at 32 000 feet agl, and a temperature of 24 degrees Celsius (°C).

After the accident, the Penticton FSS recorded a special weather observation at 1147. The only changes included a shift in the wind to 320°T at 5 knots and a temperature of 25°C.

The weather conditions at Penticton at the time of the accident exceeded the minima required for VFR flight.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

1.9.1 Penticton FSS

The three FSS specialists on duty in the Penticton FSS constituted normal staffing for the time of day. The Downstairs position is the only 24-hour position. When the Radio or Support position is operational, the Downstairs position can monitor the Penticton MF, but normally does not. The position is not directly involved with the traffic activity in the vicinity of the Penticton airport.

The primary responsibility of the Radio position is communication with all aircraft within the Penticton MF area. The FSS MANOPS prioritizes the services to be provided as follows: 1) emergency situations, and 2) in-flight services. In-flight services include airport advisory service (AAS), which consists of the following information, normally in the following sequence:

1. aircraft traffic (pertinent traffic), including, when known:
   a. aircraft type;
   b. direction of flight, altitude, and the pilot's stated intentions; and
   c. other information to assist aircraft in establishing visual separation;
2. preferred or active runway (number);
3. wind (direction, speed);
4. altimeter (setting);

5. ground traffic; and
6. supplementary information.

FSS MANOPS 811.4 states:

> Provide traffic information updates if you become aware of potential conflicts or unusual circumstances (e.g. poor communications, unfamiliar terrain, requirement to monitor other frequencies, urgent and emergency situations, bilingual communications, etc.).
>
> Note 1: Potential conflict is a situation where an aircraft must alter its flight path to avoid another aircraft.
>
> Note 2: Traffic information update is any new information since the initial advisory which is essential to the safety of the flight.

The primary responsibility of the Support position is to provide assistance to the Radio position. This duty includes receiving air traffic control clearances from the Vancouver Area Control Centre via land-line and handling telephone calls and faxes related to aircraft and vehicle activity at the Penticton airport. Both positions can hear incoming transmissions on the MF and the ground control frequency.

The responsibilities of the Downstairs position include taking weather observations, providing pilot weather briefings, copying flight plans, providing flight information service en route, providing remote communication outlet services for the Kelowna airport, monitoring navigation aids, and other miscellaneous duties. This position assumes all responsibilities when the other FSS specialist positions are not in operation. FSS specialists may relay air traffic control clearances; however, they are not authorized to issue clearances to aircraft.

The FSS is not equipped with any technology-based aids, except an emergency direction-finding unit, to assist specialists to develop or maintain situational awareness of aircraft positions within the MF area.[2] The direction-finding unit is used in determining the bearing of an aircraft that is transmitting or to provide bearing information to a pilot, if requested.

At the time of this midair collision, the two accident aircraft were the only known air traffic in the MF area, an area of about 80 square nautical miles. These two aircraft had been the only known air traffic in the Penticton area for about three minutes before the collision, that is, since about the time the pilot of the Mooney reported passing the Naramata NDB. Both FSS specialists at Penticton described the workload at the time as light, and communication records

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2 A direction-finding unit is an instrument in the FSS that provides a digital readout of the aircraft bearing from the very high frequency direction-finding (VHF D/F) site.

show that the FSS had communicated with four aircraft and one staff vehicle in the 11 minutes before the accident.

1.9.2 Pilot Communication Responsibilities

Pilots are required to make a number of standard radio calls and to monitor the MF frequency when operating within an MF zone. The specific radio calls and the associated MF procedures are detailed in section RAC (Rules of the Air and Air Traffic Services) of Transport Canada's *Aeronautical Information Publication* (AIP). AIP RAC 4.5, Aircraft Operations—Uncontrolled Aerodromes, spans seven pages and refers to a diagram that is eight pages away, in a non-applicable section. Information from pertinent sections of AIP have been included in sections 1.17.5 and 1.17.6 of this report.

1.9.3 Communication Summary

The FSS communication records show that both of the accident aircraft were in two-way communication with the Penticton FSS on the MF during the seven minutes before the collision. A summary of communication exchanges between the pilots of both accident aircraft and the Penticton FSS on the MF follows:

> At 1129, the pilot of the Mooney was already on the MF. The pilot of the Cessna made initial contact with the Penticton FSS on the MF and advised that he was ready to taxi for a VFR flight to Valemount. The FSS responded with an airport advisory that included a traffic advisory for three aircraft inbound to the airport, including the Mooney, and indicated that runway 34 was the active runway. The pilot of the Cessna acknowledged the traffic.
>
> At 1130, the pilot of the Mooney advised the Penticton FSS that he was six miles northeast and proceeding toward Naramata for descent, before joining the circuit for runway 34.
>
> At 1133, the pilot of the Mooney reported passing by Naramata and turning inbound to the airport.

At 1134, the pilot of the Mooney revised his routing with the Penticton FSS; he now intended to proceed down the west shoreline, remaining west of "the track", and he requested traffic in that area.[3] The FSS advised that there was no reported traffic in that area at the time. The pilot replied that he would report right-hand downwind for runway 34.

Twenty-five seconds later, the pilot of the Cessna advised the FSS that he was ready to depart runway 34. The FSS acknowledged, and no other information was exchanged. The pilot of the Cessna then advised that he was rolling and began his take-off.

1.10 Airport Information

The Penticton airport control tower was closed in 1995; AAS is now provided by Nav Canada through an onsite FSS. This change in service was, and remains, a controversial issue in the Penticton community.

The Penticton airport is certificated and operated by Transport Canada. It is located in the Okanagan valley at latitude 49°27' North and longitude 119°36' West, adjacent to the city of Penticton. The city and the airport are on a narrow strip of land that separates Okanagan Lake, to the northwest, and Skaha Lake, to the southeast. The two lakes are connected by a canal that runs through the city. The airport elevation is 1129 feet above sea level (asl) and is served by runway 16/34, which has an asphalt surface 6000 feet long by 148 feet wide and a heading of 161°/341°M. Runway 34 has a displaced threshold of 300 feet. *Canada Flight Supplement* states that circuits for runway 34 at the Penticton airport are right-hand. The manoeuvring area is confined by terrain.

In 1995, after completion of a rationalization study, the airport control tower was closed. The tower had been operating limited hours, and the Penticton FSS, which operated 24 hours a day, would provide an AAS when the tower closed for the day. The FSS now provides an AAS at all times. With the closing of the tower, the airport changed from a controlled airport with a positive control zone to an uncontrolled airport with an associated MF area. The Penticton airport is surrounded by a control zone with a radius of 5 nm, extending up to 4100 feet asl. This control zone is designated as Class E airspace, which includes control zones without an operating control tower. This airspace designation allows aircraft operating under instrument flight rules (IFR) to arrive and depart subject to air traffic control clearances without leaving controlled airspace. The Penticton airport is uncontrolled, and IFR and VFR operations are

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[3] The specialist working the Radio position believed that "the track" referred to the extended centreline of runway 34.

permitted. This same control zone is also designated as the MF area. Position reporting, information from the FSS, and the see-and-be-seen principle are the means employed for traffic separation at uncontrolled airports.

1.11 Flight Recorders

Flight recorders were not fitted in either aircraft, nor were they required to have been.

1.12 Wreckage and Impact Information

The in-flight collision resulted in three separate wreckage sites. After the collision, the inbound Mooney continued briefly along the original direction of flight before descending steeply onto the terrain. The departing Cessna immediately descended steeply, struck the terrain, and burst into flames. The Mooney's vertical stabilizer and a section of each aircraft's right wing landed on the city's waste treatment plant property.

The Penticton NDB tower is 1 nm north of the departure end of runway 34, on the extended runway centreline. The Mooney wreckage site was on a bearing of 132°M, 1970 feet from the Penticton NDB tower, 4580 feet north of the departure end of runway 34. The Cessna wreckage site was on a bearing of 210°M, 440 feet from the Penticton NDB tower, 5940 feet north of the departure end of runway 34. The third wreckage site was on a bearing of 162°M, 1330 feet from Penticton NDB tower.

1.12.1 Mooney M20C

The Mooney struck the ground upright in a steep nose-down attitude in an asphalt-surfaced factory work yard, narrowly missing workers. All flight instruments, engine instruments, and radio equipment were destroyed. No fire occurred at this site. Information gathered from the Mooney wreckage indicates that one communication radio was set to the Penticton MF of 118.5 megahertz. The emergency locator transmitter (ELT) was in a mounting attachment with the switch in the armed position. No ELT signal was received by the Penticton FSS. It was not determined why no signal was heard or if, in fact, the ELT transmitted a signal. The wing flaps and the landing gear were retracted.

At the point of ground impact were the propeller (still intact with one blade scarred and bent), powdered glass from the landing light lens, and impact marks in the asphalt surface from the severed right wing spar. From the point of impact, the wreckage was disbursed predominantly to the east. The front section of the Mooney, ahead of the passengers seats, was found upside-down within 15 feet of the impact point, while the remainder of the fuselage was found 30° to the right, 50 feet from the impact point. The right horizontal stabilizer showed damage consistent with a propeller blade strike. The damage was from the bottom through the top and progressed from the rear to the front. In addition, the forward, outboard end of the right horizontal stabilizer was sheared off at 40° to the leading edge (when viewed from above, with one side of the angle formed by the leading edge, from the outboard end to the strike mark).

1.12.2 *Cessna 177RG*

The aircraft struck the ground upright on an easterly heading, in a steep nose-down attitude, in a vacant asphalt-surfaced parking lot, and burst into flames. The wreckage was destroyed by fire except for the empennage. The wreckage site was compact, with minor disbursement of miscellaneous materials. All flight instruments, engine instruments, and radio equipment were destroyed, and no useful information was gathered from them. The ELT was not found, and no ELT signal was received by the Penticton FSS. The wing flap actuator was later recovered; a measurement of extension indicated that the flaps were extended 9° at the time of collision. This setting is consistent with the pilot's operating handbook (POH) recommendation to use 0° to 10° of flap for take-off. The landing gear was retracted.

The propeller hub and one blade were found together under the main wreckage but were not attached to each other. The missing propeller blade was recovered from a field about 550 feet north of the main wreckage.

The separated outboard section of the right wing was recovered from the waste treatment plant property 1100 feet southeast of the main wreckage. It was severely damaged and was found near the separated wing section and vertical stabilizer of the Mooney.

1.12.3 *Wing Wreckage Site*

The outboard sections of the aeroplanes' right wings were found close to each other at the waste treatment plant. The Mooney's vertical stabilizer was later recovered from one of the treatment ponds at this site. This site is between the two main wreckage sites and is at the west end of Waterloo Avenue, about 1060 feet west of the Mooney wreckage.

The Cessna's wing section, with a piece of the aileron attached only by the control rod assembly, was severely damaged. The Mooney's wing section was relatively intact and showed damage consistent with two propeller blade strikes, both from the bottom through the top. The first strike mark formed an angle of 45° to the leading edge of the wing (when viewed from above, with one side of the angle formed by the leading edge, from the wing tip to the strike mark). It measured 8.5 inches in length and began at 84.5 inches from the wing tip, as measured along the leading edge. The second strike mark formed an angle of 130° to the trailing edge of the wing (with one side of the angle formed by the trailing edge, from the wing tip to the strike mark). This strike mark began in the wing flap, 1 inch aft of the wing trailing edge and 93 inches from the wing tip, as measured along the trailing edge. Combined with the shearing forces of the collision, this strike severed the wing on the outboard side of the main landing-gear wheel well.

The Mooney's vertical stabilizer showed some shearing damage from an unidentified source.

1.13 Medical Information

A review of both pilots' medical records did not provide any indication of prior medical conditions that would have adversely affected their performance. Similarly, the results of the autopsies and the toxicology tests did not indicate the presence of disease or conditions likely to have led to incapacitation or impairment before the collision.

1.14 Fire

The Cessna burst into flames at ground impact and was consumed. The fire was extinguished by the Penticton Fire Department and was contained to the aircraft and a small area of the adjacent field.

No fire occurred at the crash site of the Mooney or at the separate location of the two wing sections and the vertical stabilizer.

1.15 Survival Aspects

The magnitude of the forces experienced by the occupants of both aircraft during this accident was extremely high, well above the levels of human tolerance.

1.16 Tests and Research

1.16.1 Collision Geometry

Vector diagrams of the estimated flight paths of both aircraft before the collision are based on the following information:

1. The Cessna departed runway 34. The wind was calm. The aircraft maintained the runway heading of 340°M. The recommended climb speed range is 85 to 100 knots. The landing gear was retracted, and the flaps were extended to 9°. The propeller rotates in a clockwise direction when viewed from the pilot's seat.

2. The Mooney was flying on a heading of 115°M at the point of collision, based on a heading of 340°M for the Cessna and the initial propeller strike angle of 45° to the leading edge of the right wing of the Mooney. Scratches on the bottom of the severed right wing section form an angle of about 18° clockwise from the longitudinal axis of the aircraft, which forms one side of the angle as viewed from above. This angle indicates the combined collision vector of the two aircraft. A diagram of the same vector, constructed by connecting the two measured propeller strikes in the right wing, forms an angle of 16°.

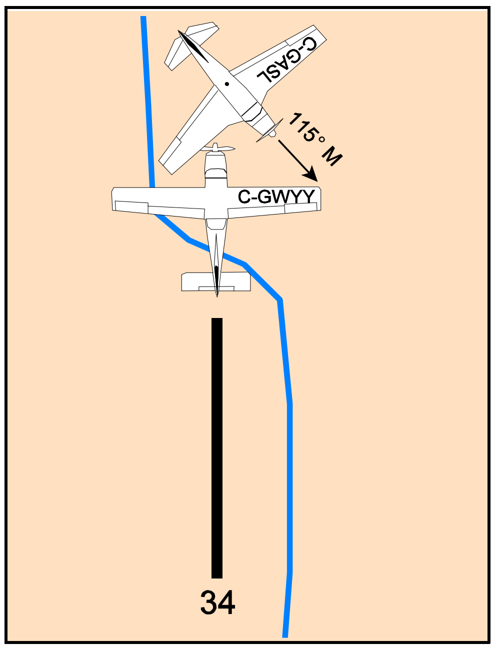

Figure 2 – Collision Flight Paths

1.16.2 Cessna 177RG

The take-off and climb performance for the Cessna under the existing weather conditions was estimated from information provided in the POH. Assuming that the pilot flew the aircraft in accordance with the POH, after lift-off he retracted the gear, reduced engine power to 2500 revolutions per minute and 25 inches of manifold pressure, maintained 9° of flaps, and climbed at 85 knots. Under these conditions, the average rate-of-climb would be about 500 feet per minute, and the aircraft would have reached a height of 500 to 700 feet above the airport elevation at the time of the collision. This estimate is consistent with other calculations that were based on witness observations.

1.16.3 Mooney M20C

At a point over the shoreline, abeam the West Bench area, the Mooney turned left and proceeded southeast, almost parallel to the canal. It was not determined if the aircraft was climbing, descending, or maintaining altitude at the time of the collision. Propeller strike damage to the leading edge of the Mooney's right wing indicates an approach angle between the two aircraft of about 45° from the Mooney's right, front quadrant and from the Cessna's left, front quadrant.

The combination of the Mooney's heading and configuration—no flaps or landing gear extended—at the point of collision indicates that the pilot was not intending to land on runway 16 at Penticton. He was told that runway 34 was the runway in use.

1.16.4 Constant Relative Bearing

It is commonly known that a person will visually acquire a moving object more readily than a stationary one. When two aircraft are on a collision course and neither is turning, each has a constant relative bearing to the other. This means that each aircraft, if seen, would appear to be motionless to the other pilot. This apparent lack of motion increases the difficulty of detecting the other aircraft.

1.17 Other Information

1.17.1 Visual Limitations from Aircraft Design

A low-wing aircraft increases the difficulty of visually acquiring conflicting traffic on the high side of the turn because the rising wing and the associated roll of the fuselage impair the sightlines and the reference to the horizon.

1.17.2 Physiological Limitations of the Human Eye

The eye has an inherent physiological defect where the optic nerve, which carries information from the eye to the brain, attaches to the retina. Because this connection point has no photo receptors, each eye has a blind spot, for which the other eye normally compensates. When looking at an object with one eye closed, the image still appears to be complete because the brain paints in a background of colour and texture to hide the blind spot so that there are no holes in the image seen. At a distance of 500 feet, an object the size of a truck can be completely covered by this blind spot.[4]

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[4] Transport Canada, "Where the Hell Did He Come From!", *Aviation Safety Vortex*, TP202E, issue 5/99.

1.17.3 Midair Collision Defences

Safety in aviation is based primarily on the concept of defences built into the system. Recommended procedures, technical assistance, and communication provide forms of defences and redundancy to reduce the likelihood of a single failure leading to a catastrophic event.

For uncontrolled airports within a mandatory frequency area, the primary element of defence is provided by the principle of see-and-be-seen. The responsibility for seeing and avoiding other aircraft rests with every pilot whenever flights are conducted under visual meteorological conditions. Under certain circumstances, physiological limitations of the eye, angular size of the approaching traffic, cockpit distractions, workload, and numerous other factors may adversely affect a pilot's ability to see approaching traffic.

A second element of defence and redundancy is provided through recommended or mandatory procedures. These procedures are published to encourage commonality of operations. When non-standard procedures are used, especially when they are not communicated, other users of the airspace may not be aware of actions being taken and a conflict may occur.

A third element of defence and redundancy is provided through communication on the MF. This element requires all pilots within a defined area to communicate on a prescribed frequency. Pilots are required to transmit position reports and to maintain a listening watch for position reports from other pilots. This procedure allows pilots to provide their own separation from each other and to organize themselves in a safe and orderly manner. Research conducted by the Lincoln Laboratory during traffic alert and collision-avoidance system (TCAS) flight testing showed a 50 per cent improvement in the visual target acquisition rate by pilots alerted to the presence of other aircraft, and the median range of visual acquisition improved by 40 per cent.[5]

The provision of an FSS provides a fourth element of defence through redundancy by requiring all pilot transmissions within the MF area to be directed to the FSS, thereby placing a third party in the communication chain. The responsibility of the FSS is to provide an AAS that includes the dissemination of traffic information pertinent to the existing conditions.[6] An FSS provides advisory information only and is not responsible for air traffic control or traffic separation.

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[5] J.W. Andrews, "Modeling of Air-to-Air Visual Acquisition", *The Lincoln Laboratory Journal*, 2, 3, 1989, p. 478.

[6] Nav Canada, FSS MANOPS, parts 810 and 811.

1.17.4 *Statistics*

According to Transport Canada, FSSs were in operation at 78 Canadian airports at the time of the occurrence. FSSs provided remote AAS to 36 additional airports. However, FSSs do not provide AAS for airports with 24-hour control tower service.

Nav Canada gathers statistical information regarding loss-of-separation and risk-of-collision events involving aircraft operating under IFR within controlled airspace. A meaningful comparison, however, cannot be made to the number of the same events that may occur in uncontrolled airspace because records are not kept of the number of aircraft operations in uncontrolled airspace. Information available does indicate that in 1998 there were 2 351 312 aircraft movements (a take-off or a landing) at Canadian airports not served by an operating control tower. In the 10 years preceding this accident, 17 midair collisions occurred. Of these accidents, 8 involved some form of formation flight, 3 occurred in practice training areas, and 6 occurred in the vicinity of uncontrolled airports between aircraft that were not associated with each other. None of these accidents occurred within the control zone of airports where air traffic control was providing an advanced level of service (that is, with an operating control tower or where an FSS was providing an AAS).

1.17.5 *Circuit Procedures—Uncontrolled Aerodromes*

Rules and procedures pertaining to circuits at uncontrolled airports are widely distributed by Transport Canada and form the basis for safe manoeuvring in the vicinity of aerodromes.

AIP RAC 4.5 prescribes the procedure that pilots are required to follow when operating at an uncontrolled airport. Rules applicable to this occurrence have been excerpted from RAC 4.5:

> 4.5.2 **Traffic Circuit Procedures—Uncontrolled Aerodromes**
>
> The following procedures apply to all aircraft operating at aerodromes where airport control service is not provided except those aircraft following a standard instrument approach procedure. . . . Prior to joining a traffic circuit, all pilots should announce their intentions. . . . All turns shall be to the left while operating in the circuit, unless a right-hand circuit has been specified in the CFS [*Canada Flight Supplement*]. . . .

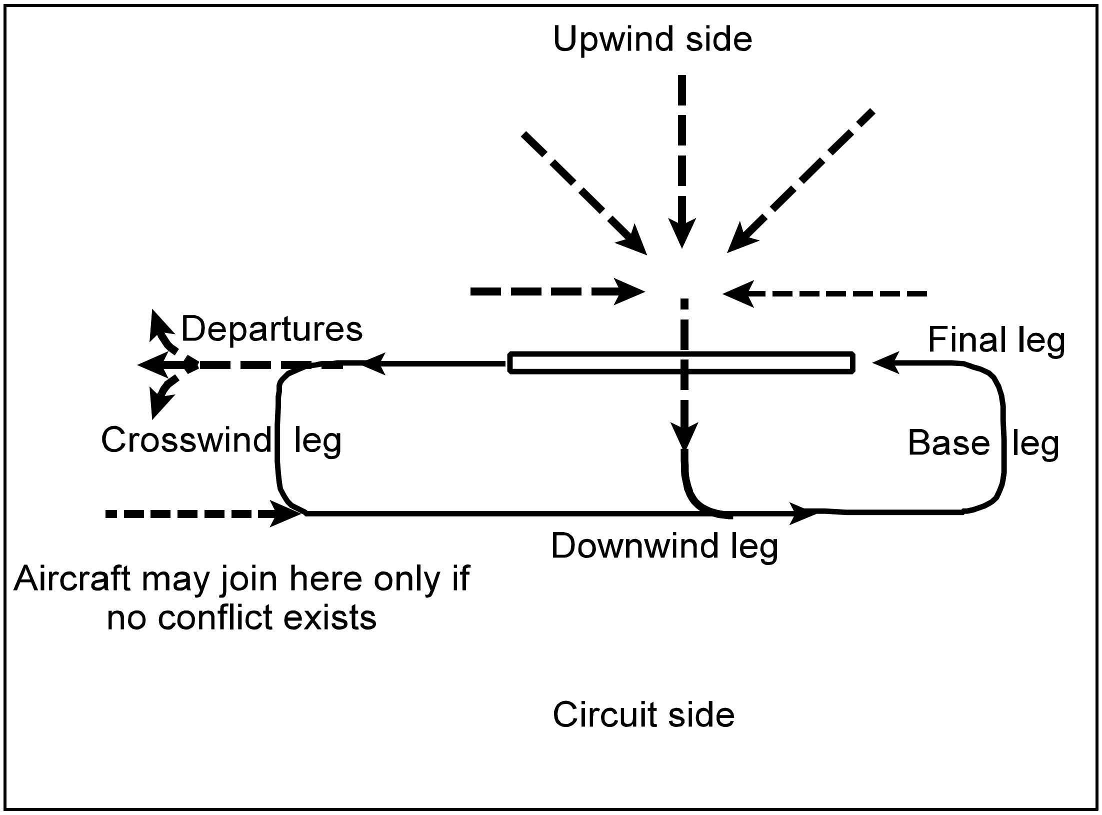

Figure 3 - Standard left-hand circuit pattern

NOTES: 1. The circuit is normally flown at 1 000 [feet] AAE [above aerodrome elevation].

2. If a right-hand circuit is required in accordance with CAR 602.96, the opposite of this diagram is applicable.

(a) Joining the Circuit

. . .

(ii) . . . When joining from the upwind side, plan the descent to cross the runway in level flight at 1 000 [feet] AAE or the published circuit altitude. Maintain that altitude until further descent is required for landing. . . .

(vi) Aerodromes within an MF area when airport advisory information is available: Aircraft may join the circuit pattern straight-in or at 45° to the downwind leg or straight-in to the base or final legs (Figure 4.1). Pilots should be alert for other VFR traffic entering the circuit at these positions and for IFR straight-in or circling approaches. . . .

(c) Departing the Circuit or Airport

Aircraft departing the circuit or airport should climb straight ahead on the runway heading until reaching the circuit traffic altitude before commencing a turn in any direction to an en route heading. Turns back toward the circuit or airport should not be initiated until at least 500 [feet] above the circuit altitude.

The circuits for runway 34 at the Penticton airport are right-hand. Therefore, the procedure described in AIP is opposite.

1.17.6 Communication Procedures—Uncontrolled Airports

AIP RAC 4.5.4 and 4.5.7 prescribe the communication procedures pertaining to an airport where an MF is in effect:

4.5.4 **Mandatory Frequency**

. . . Reporting procedures shall be followed, as specified in CARs 602.97 to 602.103 inclusive.

An MF area will be established at an aerodrome if the traffic volume and mix of aircraft traffic at that aerodrome is such that there would be a safety benefit derived from implementing MF procedures. . . . When a ground station is in operation, for example, an FSS, . . . then all aircraft reports that are required for operating within, and prior to entering an MF area, shall be directed to the ground station. . . .

4.5.7 **VFR Communication Procedures at Uncontrolled Aerodromes With MF and ATF Areas**

(a) Radio-Equipped Aircraft

The following procedures shall be followed by pilots of radio-equipped aircraft at uncontrolled aerodromes within an MF area and should also be followed by pilots at aerodromes with ATFs:

(i) Operations on Manoeuvring Area

Report intentions prior to entering the manoeuvring area, and maintain a listening watch on the MF or ATF frequency while operating an aircraft on the manoeuvring area. (CAR 602.99)

(ii) Departure

(A) Complete pre-takeoff check, and report departure intentions on the MF or ATF frequency before moving onto the runway. If a delay is encountered, broadcast intentions and expected length of delay; . . .
(B) Ascertain by radio on the MF or ATF frequency and by visual observation that no other aircraft or vehicle is likely to come into contact with the aircraft during takeoff; and
(C) Report departing from the aerodrome traffic circuit, and monitor the MF or ATF until well clear of the area (5–10 NM). (CAR 602.100) [Added to regulation April 2001.]

(iii) Arrival

(A) Report position, altitude, arrival procedure intentions and estimated time of landing at least 5 minutes (where possible) prior to entering the area;
(B) Maintain a listening watch on the MF or ATF while in the area;
(C) Report joining the circuit pattern giving position in the pattern;
(D) Report on downwind leg, if applicable;
(E) Report established on final approach; and
(F) Report clear of the active runway after landing. (CAR 602.101) . . .

2.0 Analysis

2.1 General

This accident can be described as a "non-associated midair collision".[7] This means that the pilots involved were not intentionally flying in close proximity as they would if they had been involved in a formation flight. Given the circumstances of this accident, it is likely that, although each pilot was probably generally aware of the other—through radio communications—neither one was specifically aware of the location of the other aircraft. During the investigation into this accident, no mechanical defect with either aircraft was found, nor was there any indication of pre-existing disease or conditions likely to have led to the pre-impact incapacitation or impairment of either pilot. To address the issues of why these two aircraft were in each other's vicinity without knowing the other was there, this analysis will examine airport traffic circuits, circuit-joining procedures, communication procedures, and the see-and-be-seen principle. Rules and procedures that address right-of-way issues are not discussed in this report because they cannot be applied to non-associated collisions; that is, one cannot be expected to give way to another if one is not aware of the other. Weather is not considered a contributing factor in this accident.

2.2 Circuit Procedures and Communications Procedures

2.2.1 Mooney M20C

When the Mooney passed by the Naramata NDB to return to the airport, the pilot reported that he would proceed along the west shoreline of Okanagan Lake, remaining west of "the track", and he requested traffic information for that area. The FSS replied that there was no reported traffic in that area but did not advise him that there was a pending departure from runway 34, namely the Cessna.

This check-in call with the FSS was incomplete. The call did not contain a clear statement of the pilot's altitude, his intended arrival procedure, or his estimated time to landing; all of which are required by procedures. Additionally, the pilot's reference to remaining west of "the track" is ambiguous and is not standard radio terminology. The FSS specialist accepted the Mooney pilot's report without requesting amplifying information and interpreted the pilot's communications to mean that he would remain west of the extended centreline of the active runway. Based on that interpretation, the FSS specialist concluded that the Mooney would join the circuit mid-field and, therefore, would not be pertinent traffic for the departing Cessna. What is clear is that the Mooney pilot did not follow the path that was expected by the FSS specialist but, rather, followed a path that appeared to be at 45° to the downwind leg. As well, it is estimated that the Mooney was between 500 and 700 feet agl when the collision occurred,

[7] Richard H. Wood and Robert W. Sweginnis, *Aircraft Accident Investigation* (Casper, Wyoming: Endeavor Books, 1995).

below the circuit-joining height of 1000 feet AAE. This path placed the Mooney in conflict with the departing Cessna. The essential issue remains that an incomplete and ambiguous radio check-in led to a loss of awareness by the FSS (and likely other pilots in the area) of the circuit-joining intention and the position of the arriving Mooney.

The pilot of the departing Cessna made a total of four radio transmissions to the FSS regarding his departure. Although all pilots operating within the MF area are expected and required to monitor the MF, it was not determined if the pilot of the Mooney heard any of these transmissions. Records indicate that at no time was a transmission directed to the pilot of the inbound Mooney to advise him of the departing Cessna. When he was abeam the West Bench area, the pilot of the Mooney turned east onto a heading that crossed through the departure path of runway 34, evidently unaware of the departing aircraft. An opportunity that would have prevented the accident was lost when the pilot of the inbound aircraft did not communicate his specific arrival procedure intentions (that is, how he would transition from the west side of the airport to join the circuit on the east side), nor was he asked by the FSS for his intentions.

A diagram in AIP RAC 4.5.2, Traffic Circuit Procedures—Uncontrolled Aerodromes, depicts the standard traffic circuit. (See Figure 3.) The diagram indicates that to join the downwind leg of a circuit from the upwind side, the aircraft would have to cross over the airport, clear of the departure and arrival paths. The Mooney pilot appeared to be joining the downwind leg on a 45° intercept that crossed through the departure path from the upwind side. AIP RAC 4.5.2(a)(v) describes a circuit-joining procedure via a 45° downwind intercept; however, the referenced diagram (Figure 4.1 in AIP RAC) does not depict a 45° intercept to the downwind leg that would cross through the departure path. The circuit-joining technique used by the Mooney was not standard. When pilots do not communicate their intentions to use non-standard procedures, other users of the airspace anticipate that the recommended procedures will be followed. In this accident, the lack of effective communication deprived the pilots of information that could have altered their actions, either by flying a different track or by delaying departure.

2.2.2 *Cessna 177RG*

Upon initial contact with the Penticton FSS on the MF, the pilot of the Cessna was advised of the inbound Mooney during the airport advisory. After that transmission, records show that there were eight transmissions between the FSS and the pilot of the Mooney, before the Cessna departed.

Regulations and good airmanship require that the pilot of an aircraft operating on the manoeuvring area of an uncontrolled airport maintain a listening watch on the MF or the aerodrome traffic frequency (ATF) before departing. Since the Cessna pilot was communicating with the FSS on the MF, he should have been monitoring the MF, thereby allowing him to formulate a mental model of the traffic.

In the last two transmissions made by the pilot of the Mooney, he stated his intention to follow the west shoreline, remaining to the west of the track, and report downwind right-hand for runway 34. Assuming the pilot of the Cessna heard that transmission, he would have expected the Mooney to follow the recommended circuit-joining procedure prescribed in AIP RAC 4.5.2. This procedure would have taken the aircraft along the west side of the valley to a position where the pilot could turn northeastward to cross over the airport before making a right-hand turn to join the downwind leg of the circuit. Incorporating this procedure and the absence of any qualifying traffic information from the FSS into his mental model, the Cessna pilot would conclude that the Mooney was not in conflict with his departure.

The pilot of the Cessna reported on the MF that he was ready for take-off on runway 34. However, it was not determined whether the pilot ascertained by radio (through monitoring the MF) that his departure would be free of conflicting traffic, which is also required. The aircraft's flight path was consistent with a straight-out climb on the runway heading (340°M) in accordance with AIP RAC 4.5.2(c).

2.2.3 Penticton Flight Service Station

The Nav Canada FSS MANOPS requires FSS specialists to issue traffic advisories as part of the AAS. Communication records reveal that an airport advisory was provided when the pilot of the Cessna initially contacted the FSS when ready to taxi. When the pilot advised that he was ready for take-off, the FSS did not provide a traffic update. The departing pilot was required to monitor the MF, on which communications had been taking place between the FSS and the pilot of the arriving Mooney. According to FSS MANOPS, another advisory by the FSS would not be required unless the specialist believed that the traffic was pertinent or that a potential conflict existed.

When advised by the departing pilot of his departure intentions, the FSS specialist knew that an aircraft was inbound to the airport but had not established visual contact with that aircraft. The specialist had no independent means of detecting the inbound aircraft's unexpected turn to the east, which took the aircraft through the departure path of runway 34. Without the benefit of technological detection equipment, an FSS specialist's situational awareness and provision of advisory services can only be based on his or her mental picture, formulated through information received, visual contact, and the expectation that pilots will follow recommended procedures. The last information received from the pilot of the Mooney was his route along the west shore of the lake, remaining west of the track, and his intention to report right-hand downwind for runway 34. His intended circuit-joining procedure was never provided or requested.

Requesting accurate and complete position reports from the pilots of aircraft operating within the MF area may prompt conformity to recommended procedures and provide better situational awareness to the FSS specialists and other pilots. The Penticton *FSS Station Information Manual* contains a list of local reporting points, but they are not published on the applicable VFR navigation chart or in the *Canada Flight Supplement* and therefore may not be known or identifiable by all pilots. Furthermore, the use of standard phraseology helps minimize any confusion over terms such as “the track”.

2.3 *Control Tower*

Nav Canada has a formula based on the levels of traffic and other factors for the establishment and maintenance of control towers. Aerodromes in Canada that do not meet the criteria for a control tower accommodate well over two million aircraft movements per year. The purpose of a control tower at an airport is to provide information and a control service to air and ground traffic. An FSS provides information only. At higher levels of activity, a control tower would provide a higher level of both service and safety. Nothing in this investigation has shown the criteria for the establishment of control towers in Canada to be inadequate.

2.4 *Operational Circumstances*

The flight profiles of both accident aircraft suggest that neither pilot took evasive action. Since the Mooney is a low-wing aircraft with the pilots’ seats over the wings, a left bank would have improved the pilot’s view of the ground to the left but blocked his view of the ground to the right. As the bank angle increases to the left, the field of view to the right for all occupants, especially those on the left side (including the pilot), would move up into the clear sky above, completely obscuring the view of the horizon (or below) on the right side. The Mooney pilot’s field of view of the horizon from the cockpit would have been restricted by the right wing and the fuselage structure because of the left bank. Given that the Cessna was approaching the Mooney from the Mooney’s right side and that the Mooney was in a left bank, it would likely have been impossible for the pilot of the Mooney to have seen the Cessna once he was in the turn.

From the perspective of the pilot of the Cessna, the Mooney would have been approaching from the front, left quadrant. The constant relative bearing between the two aircraft on collision course probably resulted in no apparent motion and reduced the Cessna pilot’s ability to detect the Mooney. Because of the angle of approach of the Mooney, the image of it from the Cessna would have been a small-profile, frontal view. The visibility of an aircraft paint scheme is a very subjective topic because so many variables can affect it. A colour that is highly visible in one circumstance can be almost invisible in another. Even the visibility of reflective material could depend on what is being reflected. Military organizations use camouflage colours to make aircraft hard to visually detect; however, camouflage that may be effective in a jungle environment likely would not be effective in the arctic. Therefore, it is impractical to suggest that any particular paint scheme would be an effective defence against the threat of a midair collision.

Exacerbating the problem, physiological limitations of the eye may adversely affect a pilot's ability to see other aircraft. The blind spot limitation occurs when one eye is shielded by an obstruction, such as a windscreen post, while the image of the potential conflict falls into the blind spot of the other eye. If a pilot looks out the aircraft window and this phenomenon occurs, the pilot, not having seen anything, may divert his or her attention elsewhere. Even when looking in the same direction again, the pilot's head may be in the same place and the same phenomenon occurs. The problem can be resolved by the pilot changing head position, that is, leaning in any direction or manoeuvring the aircraft.

In this accident scenario, the other collision-avoidance defences had already been eroded. The see-and-be-seen principle was the last remaining defence, and it was being constrained by the Mooney's left-bank attitude, its small visual profile, the constant relative bearing effect, and, perhaps, the limitations of the human eye.

When aircraft separation depends on the see-and-be-seen principle, traffic advisories greatly assist pilots to develop and maintain a mental picture of relevant traffic. Research indicates that, if alerted to the presence of another aircraft, a pilot is much more likely to visually acquire that aircraft. However, in this occurrence, communications among the three players was ineffective, impairing the pilots' abilities to detect the other aircraft.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. Neither pilot saw the other aircraft in sufficient time to initiate evasive action.

2. The Mooney pilot did not follow recommended circuit-joining procedures.

3. The Mooney pilot's initial check-in was incomplete and ambiguous. Any mental models developed by the flight service station (FSS) specialists (or by other pilots in the area) regarding the Mooney pilot's circuit-joining intentions were based on this incomplete and ambiguous information.

4. The Penticton FSS specialist did not directly advise the Mooney pilot of the departing Cessna, although the departure transmission by the Cessna to the FSS should have been heard by the pilot of the Mooney.

5. The Penticton FSS specialist did not obtain and provide a traffic update to the Cessna pilot when he was ready to depart. Another advisory was not required unless the specialist believed that the traffic was pertinent or that a potential conflict existed.

6. The Cessna pilot did not request a traffic update from the Penticton FSS when he was ready to depart. It is unknown whether the pilot monitored the mandatory frequency to ascertain that his departure would be free of conflicting traffic.

3.2 Findings as to Risk

1. The see-and-be-seen principle has inherent limitations that can preclude effective separation of aircraft on a collision course.

3.3 Other Findings

1. It was not determined whether either aircraft was using an external lighting system.

4.0 Safety Action

4.1 Action Taken

1. The Penticton flight service station (FSS) has amended its ongoing training program to include increased emphasis on areas of situational awareness, scanning techniques, provision of traffic updates, position reports, and rules and procedures for pilots in mandatory frequency areas.

2. The Penticton FSS has submitted a revised VFR Terminal Procedures Chart (VTPC) to Nav Canada for approval. This revised chart would replace the existing VTPC in the *Canada Flight Supplement* and incorporates established reporting points in the Penticton area.

3. Nav Canada is conducting pilot education sessions on air traffic procedures. The TSB and Transport Canada have participated by providing information on recent midair collisions and the limitations of human recognition and response. Nav Canada will also emphasize the reporting of non-standard aerodrome procedures.

4. Transport Canada is launching a safety video that covers procedures in the vicinity of aerodromes. This initiative is already under way and is not a direct result of this accident.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 11 July 2001.

Appendix A—Glossary

AAE	above aerodrome elevation
AAS	airport advisory service
agl	above ground level
AIP	*Aeronautical Information Publication*
asl	above sea level
ATF	aerodrome traffic frequency
CARs	*Canadian Aviation Regulations*
CPL–A	Commercial Pilot Licence—Aeroplane
ELT	emergency locator transmitter
FSS	flight service station
FSS MANOPS	*Flight Service Station Manual of Operations*
IFR	instrument flight rules
MF	mandatory frequency
nm	nautical mile(s)
NDB	non-directional beacon
PDT	Pacific daylight time
POH	pilot's operating handbook
PPL–A	Private Pilot Licence—Aeroplane
RAC	"Rules of the Air and Air Traffic Services" (in AIP)
TCAS	traffic alert and collision-avoidance system
TSB	Transportation Safety Board of Canada
VFR	visual flight rules
VTPC	VFR Terminal Procedures Chart
°	degree(s)
°C	degrees Celsius
°M	degrees magnetic
°T	degrees true
'	minute(s)