Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A07Q0213

LOSS OF CONTROL AND COLLISION WITH TERRAIN

AIR CREEBEC INC.
BEECHCRAFT A100 C-FNIF
CHIBOUGAMAU/CHAPAIS AIRPORT, QUEBEC
25 OCTOBER 2007

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

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Summary

The Beechcraft A100 (registration C-FNIF, serial number B-178), operated by Air Creebec Inc. on flight CRQ 501, was on a flight following instrument flight rules between Val-d'Or, Quebec, and Chibougamau/Chapais, Quebec, with two pilots on board. The aircraft flew a non-precision approach on Runway 05 of the Chibougamau/Chapais Airport, followed by a go-around. On the second approach, the aircraft descended below the cloud cover to the left of the runway centreline. A right turn was made to direct the aircraft towards the runway, followed by a steep left turn to line up with the runway centreline.

Following this last turn, the aircraft struck the runway at about 500 feet from the threshold. A fire broke out when the impact occurred and the aircraft continued for almost 400 feet before stopping about 50 feet north of the runway. The first responders tried to control the fire using portable fire extinguishers but were not successful. The Chibougamau and Chapais fire departments arrived on the scene at about 0926 eastern daylight time, which was about 26 minutes after the crash. The aircraft was destroyed by the fire. The two pilots suffered fatal injuries.

Ce rapport est également disponible en français.

Other Factual Information

Company Information

Air Creebec Inc. holds a valid operations certificate (number 8582). At the time of the occurrence, the company was operating a fleet of 18 aircraft: one Beechcraft 1900D, three Embraer 110s, three HS-748s, eight DHC-8s and three Beechcraft A100s. Depending on the type of aircraft used, operations are carried out in compliance with Subparts 3, 4, and 5 of Part VII of the *Canadian Aviation Regulations* (CARs) [1]. In this occurrence, the aircraft was being used in compliance with Subpart 3.

Aircraft Information

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. There was no evidence found of any airframe failure or system malfunction during the flight.

The aircraft was equipped with a cockpit voice recorder (CVR), model Universal CVR 30B. The CVR was removed from the aircraft and sent to the TSB Engineering Laboratory for analysis. The recorded information and conversations made it possible to retrace the events of the last 30 minutes of the flight before the occurrence.

Flight Crew Information

The flight crew was certified and qualified for the flight in accordance with existing regulations. The pilot-in-command had been employed with the company since 05 July 2007. He had a total of about 1800 flying hours, including 122.9 hours on the Beechcraft A100 as pilot-in-command. He had performed his last line check on 23 September 2007. Prior to joining Air Creebec, he had worked in the West Indies as pilot-in-command on the BN 2A-26 and as co-pilot on the DHC-6, on which he had 403 and 530 flying hours, respectively, mainly in visual flight conditions.

The co-pilot had been employed with the company since 11 June 2007 and had a total of about 1022 flying hours, including 71.9 hours on the Beechcraft A100. He had performed his line check on 22 August 2007. When he joined the company, he already had about 950 flying hours, including 31 hours on twin-engine aircraft. Almost all of his flying experience had been in visual flight conditions.

Both pilots passed the initial pilot proficiency check (PPC) on the Beechcraft A100 as well as the renewal of their instrument flight rating on 25 July 2007. Also, they completed crew resource management (CRM) training on 11 June 2007. CRM training consists of a number of elements, notably communication, teamwork, decision making and judgment, workload management, and situational awareness.

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[1] See Appendix C, Glossary, for a list of abbreviations and acronyms.

There is a shortage of pilots in the aviation industry, not only in Canada but around the world. The International Air Transport Association has warned the world's airlines of a serious lack of pilots if the industry and governments do not work together to change training and qualification methods. This shortage is making it increasingly difficult for operators to find experienced pilots.

History of the Flight

In the days leading up to the accident, the pilot-in-command had three days off and the co-pilot had six days off. They had worked together as flight crew members three times since they were hired. On the day of the accident, both pilots arrived at work at about 0445 [2] or one hour before the initially scheduled departure time. There was no indication that the crew was not fit to fly. Because of the weather conditions in Chibougamau/Chapais, the dispatcher, jointly with the pilot-in-command, delayed the departure from Val-d'Or. The aircraft took off from Val-d'Or at 0800.

According to the planned route, the crew was to go to Chibougamau/Chapais to pick up two passengers before going to Bagotville, Quebec. The return to Val-d'Or was scheduled for 1810.

The aircraft took off from Val-d'Or with the two pilots on board and enough fuel to fly for about five hours. The weight and centre of gravity of the aircraft were within the limits prescribed by the manufacturer. Most of the flight was carried out above the cloud layer at an altitude of 15 000 feet above sea level (asl). No anomalies were reported by the crew. The co-pilot seated on the right was the pilot flying (PF) and the pilot-in-command was the pilot not flying (PNF).

Before starting the descent, the flight crew had planned to fly an approach for Runway 23. The surface wind reported was 260 degrees at 5 knots. The pilot-in-command started programming the RNAV (GNSS) RWY 23 [3] approach in one of the global positioning systems (GPSs) installed on board. The intent was to carry out an RNAV (GNSS) approach and monitor the raw data from the automatic direction finder (ADF) [4]. A few minutes later, to shorten the flight, the flight crew opted for a direct approach to Runway 05 because the surface wind at Chibougamau/Chapais was light.

At approximately 0833, on the en route frequency 126.7 MHz, the crew advised Propair 102, another King Air that was 21 miles behind it, that it was proceeding to Runway 05. Propair 102 confirmed that it would continue to Runway 23. The crew of CRQ 501 completed the briefing for the NDB/DME RWY 05 approach (see Appendix A) before starting the descent at about

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2 All times are eastern daylight time (Coordinated Universal Time minus four hours).

3 Instrument approach procedure in which the global navigation satellite system (GNSS) is used.

4 Direction-finding equipment for obtaining a bearing to or from the radio beacon.

0836. The aircraft was 47 nautical miles (nm) from Chibougamau/Chapais within an acceptable descent profile. The estimated arrival time at CHIBOO non-directional beacon (NDB) was at 0845 while Propair 102 estimated its arrival at Chibougamau/Chapais airport at 0901.

Despite the briefing for the NDB/DME 05 approach, the pilot-in-command started programming the RNAV (GNSS) 05 approach (see Appendix B) in one of the GPSs. The investigation could not determine which GPS was used. Neither of the pilots was authorized nor trained to use the GPS as a primary source of navigation for an instrument approach. The programming was done during the descent over a period of about nine minutes. It was abandoned at about 15 nm from the runway threshold. At that time, the aircraft had a ground speed of about 210 knots and the crew had not started the aircraft's approach configuration. The approach configuration was obtained when passing final approach fix (FAF) LEGER and the pre-landing checklist was completed when the aircraft was about 2 nm from the Runway 05 threshold. According to the standard operating procedures (SOPs), these actions must be completed when the final inbound course is intercepted before passing the FAF.

Between 0847 and 0851, the Propair 102 crew broadcast four radio transmissions during which they indicated the aircraft was proceeding towards Runway 05. The first two transmissions were sent on the mandatory frequency (MF), which is 122.0 MHz. At this time, the crew of CRQ 501 had not yet tuned the frequency. The third transmission was sent on frequency 126.7 MHz, which was tuned by the crew of CRQ 501. This last transmission was sent as CRQ 501 reached the minimum descent altitude (MDA). At this time the PNF's attention was focused on a visual scan of the exterior to locate the runway and its surroundings while the PF's attention was focused on maintaining the desired track, airspeed, and the MDA.

At 0849, when the aircraft was less than two miles from the runway threshold, the PNF made his first position report on final approach on 126.7 MHz. Section 602.104 of the CARs requires that an aircraft's position be reported on the MF when the aircraft first intercepts the final approach course and when passing the FAF, which was not done. After this late position report, the Québec Flight Information Centre (FIC) asked the crew about its familiarity with the MF area and then provided the winds and the altimeter setting for Chibougamau/Chapais. During this transmission, the crew saw the runway slightly to its right and performed a go-around. During this approach, the aircraft radio control of aerodrome lighting (ARCAL) had not been activated by the crew.

At 0850, the crew carried out the missed approach procedure. During this time, Propair 102 was advised by the Québec FIC that CRQ 501 was doing a go-around and Propair 102 repeated for the fourth time on the MF that it was proceeding towards Runway 05. This transmission was sent while the crew of CRQ 501 was busy with the tasks and calls applicable to a go-around. Propair 102 then activated the ARCAL.

For the second approach, the crew opted for a pilot-in-command monitored approach (PICMA) procedure. The aircraft initially climbed to 3200 feet asl, as published on the approach chart. The crew indicated that it would carry out a procedure turn. However, the radar data showed that, upon reaching 3200 feet asl, the aircraft turned left to carry out a race-track pattern instead.

This type of pattern is usually done from a FAF (see Figure 1). When flying over the FAF, the aircraft turns and usually travels for one or two minutes on an outbound course parallel to the final approach path. It then turns approximately 180° again to intercept the final path. It is only by passing abeam of the FAF on the outbound course that the aircraft can descend to the minimum procedure turn altitude in order to maintain the minimum obstacle clearance. In the case of this occurrence, the crew descended to the procedure turn altitude once the aircraft passed abeam of the CHIBOO NDB, placing the aircraft 400 feet below the minimum sector altitude (MSA).

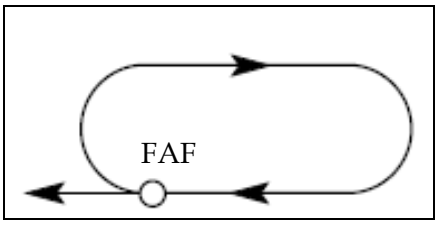

Figure 1. Race-track pattern

At 0852, Propair 102 reported itself 10 nm on final approach towards Runway 05. This was the fifth radio transmission in which Propair 102 referred to Runway 05. This transmission was sent while there was a verbal exchange between the two pilots of CRQ 501 concerning their second approach. The Québec FIC checked with the crew that it had properly copied the fact that the Propair 102 was 10 nm on final, but this transmission did not refer to Runway 05. The crew nevertheless replied that they had properly understood. However, the investigation revealed that the crew believed until the end that Propair 102 was completing an approach on Runway 23 as it had indicated in the first radio messages.

When Propair 102 passed the LEGER fix, the two aircraft were abeam each other on opposite courses. At that time, the crew of the Propair did not report its position as required by the regulations governing communications in a MF area. A distance of 3.1 nm separated the aircraft horizontally and about 1000 feet separated them vertically. At 0856, CRQ 501 initiated the turn to intercept the final approach. At this time, Propair 102 reported itself 1.5 nm from the runway threshold without mentioning the runway number. While Propair 102 was crossing the threshold for Runway 05 on an RNAV (GNSS) approach, CRQ 501 was turning to intercept the final approach at a distance of 4.6 nm from the threshold of Runway 05 and descended to about 500 feet below the procedure turn altitude before becoming established on the final approach course.

When the aircraft passed the LEGER fix, the wheels and flaps were still retracted and the ground speed was 150 knots. A few seconds later, the wheels were lowered and the flaps were lowered to the approach position. The pre-landing checklist was completed while the aircraft was less than 2 nm from the threshold of Runway 05. At 0858:46, the crew saw the runway on their right side. The co-pilot transferred the controls to the pilot-in-command and the flaps were lowered completely.

At 0859, CRQ 501 reported that it was on final approach for Runway 05. A few seconds later at the time of the Vref [5] call, which is 100 knots, the stall warning sounded and the aircraft crashed five seconds later, at 0859:13, on the runway about 500 feet from the threshold. A fire broke out when the impact occurred and the aircraft continued its course for about 400 feet before stopping about 50 feet north of the runway. The first responders tried to control the fire using

[5] Vref is the landing reference speed.

portable fire extinguishers but were not successful. The Chibougamau and Chapais fire departments arrived on the scene at about 0926. The aircraft was destroyed by the fire. The two pilots suffered fatal injuries.

Based on the autopsy and toxicology results, there was no indication that the performance of the two pilots was degraded by physiological factors.

Wreckage and Impact Information

The twin-engine aircraft struck the runway, banked approximately 55° to the left and pitched down about 20°. The collision path corresponds to a bearing of 027° magnetic (M) or about 25° off the runway centreline. The propeller marks on the runway and the disposition of the debris made it possible to establish that the aircraft's speed at the moment of impact was 94 knots and the rate of descent was high. A fire broke out on impact and the aircraft was almost completely destroyed by the fire and the force of the impact.

The aircraft was equipped with a Narco ELT 10 emergency locator transmitter (ELT). The transmitter was found in its housing in the aircraft's tail section and was partially damaged by the fire. Its switch was set to automatic activation and the ELT activated upon impact. However, due to circuit board damage, the ELT's transmission power was severely limited, which explains why no ELT signal was received after the accident.

Airport Information and Firefighting Services

The Chibougamau/Chapais Airport is located in the municipality of James Bay. The airport is operated by the Quebec Department of Transport which holds Transport Canada Operations Certificate number 5151 Q 628.

The airport has one paved runway (05/23) that is 6496 feet long and 150 feet wide. Its elevation is 1270 feet asl. The runway is equipped with an ARCAL type K [6] system. Runway 05 is equipped with approach lights, runway threshold lights, and medium-intensity runway edge lights with three settings. At the time of the occurrence, all lights were activated at their maximum intensity.

The Chibougamau/Chapais Airport does not have an aircraft rescue and firefighting (ARFF) service. It is not required according to the CARs. In emergencies, the Chibougamau firefighting service is the first responder. The fire station is 23 kilometres from the airport. Following the accident, the first firefighters arrived at the scene about 26 minutes after the emergency call.

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6 The runway lighting is activated at the highest intensity for about 15 minutes when the pilot pushes the microphone button seven times within five seconds.

In small-aircraft, post-impact fire accidents, the occupants have about 17 seconds [7] to evacuate before being overcome by smoke. This time is much shorter than the three-minute response time demonstrated by ARFF services, when available.

Weather Information

The cloud and weather chart for the graphic forecast area (GFA) valid at 0800, or the time of take-off from Val-d'Or, showed that a high-pressure area approaching from the west was forecast for the central Quebec region, with its centre located about 360 nm southwest of Chibougamau/Chapais. According to the GFA, the base and top of the clouds for the planned route were 3000 and 6000 feet asl respectively, with a forecast visibility of more than six miles.

The GFA chart showing the icing conditions, turbulence, and freezing level indicated that the freezing level started at ground level and that on the course followed by the aircraft, the crew could expect light to nil icing conditions and turbulence. However, cloud banks and moderate mixed icing between the surface and 3000 feet asl were probable in the Chibougamau area. Moreover, an AIRMET [8] issued at 0434 stated that visibility of four miles in light freezing drizzle was observed at Chibougamau/Chapais and that these conditions should clear up around 1100.

The hourly observations (METARs) for the airport come from visual observations made by accredited Environment Canada weather technicians and are transmitted on the Environment Canada communications system. The METARs for the Chibougamau/Chapais Airport showed the presence of freezing drizzle and fog for several hours preceding the accident. During these hours, visibility was reduced from four to 1½ miles. However, the special observation at 0808 showed that the freezing drizzle had stopped and that visibility was three miles in fog.

The special observation made at 0831 at the Chibougamau/Chapais Airport indicated a partly obscured sky, a balloon-measured overcast ceiling at 700 feet above ground level (agl), visibility of two miles in fog, and winds from 260° at 6 knots; the temperature and dew point were -0.8°C and -1.5°C, respectively. The 0900 hourly observation taken a few minutes before the accident showed the same conditions. A little more than 15 minutes after the accident, the ceiling had dropped to 500 feet but visibility had increased to six miles in fog. The investigation established that the top of the clouds was about 3000 feet asl.

There was no evidence that the icing weather conditions played a role in this accident. The freezing precipitation had stopped a little less than an hour before the accident. The crew did not observe any ice on the aircraft's critical surfaces. Furthermore, the investigation revealed that an aircraft which landed a few minutes earlier had not accumulated any ice on its wings.

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7 This information comes from TSB report SII A05-01, Post-impact fires resulting from small-aircraft accidents.

8 An AIRMET is a meteorological advisory for flying personnel.

Aids to Navigation

NAV CANADA is the owner and operator of the airport's communication and radio navigation equipment; they also maintain the equipment. The navigation facilities at the Chibougamau/Chapais Airport include distance-measuring equipment (DME) and an NDB.

NDB and RNAV non-precision approaches are available on Runway 05/23. At the time of the accident, a notice to airmen (NOTAM) stated that the CHIBOO NDB was unmonitored until 31 October 2007. The investigation revealed that the NDB and the DME were operating normally at the time of the occurrence.

Communications

The Chibougamau/Chapais Airport is located in Class G airspace and air traffic control does not have the authority or responsibility to control the traffic there. However, the Québec FIC does provide flight information and alerting services.

The CARs [9] state that the pilot-in-command of an instrument flight rules (IFR) aircraft who intends to conduct an approach to or a landing at an uncontrolled aerodrome shall report his intentions regarding the operation of the aircraft:

- five minutes before the estimated starting time of the approach procedure, stating the estimated time of landing;
- when commencing a circling manoeuvre; and
- as soon as practicable after initiating a missed approach procedure.

The pilot-in-command shall also report the aircraft's position:

- when passing the fix outbound, where the pilot-in-command intends to conduct a procedure turn or, if no procedure turn is intended, when the aircraft first intercepts the final approach course;
- when passing the final approach fix or three minutes before the estimated time of landing where no final approach fix exists; and
- on final approach.

The MF area of Chibougamau/Chapais extends for 5 miles. The CARs [10] state that the pilot-in-command of a visual flight rules (VFR) or IFR aircraft operating within a MF area shall maintain a listening watch on the MF specified for use in the MF area. Furthermore, according

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[9] CAR 602.104.

[10] CAR 602.97 (2).

to the CARs [11], all reports must be made on the MF. In the case of this occurrence, the crew made its first communication on the MF at 0849 when the aircraft was less than two miles from the airport and the majority of the reports required by the CARs were not done.

There are 210 MF areas in Canada. A review of the civil aviation daily occurrence reporting system (CADORS) showed that, in 2007, 165 occurrences related to non-compliance with communications procedures in MF areas in Canada were reported. In general, omission of reports is the primary reason for issuing CADORS.

Instrument Approach

The MDA published for the NDB/DME approach for Runway 05 is at 1800 feet asl, or 532 feet agl, and visibility at 1¾ miles. Because the weather conditions indicated a ceiling of 700 feet agl and visibility of two miles, an instrument approach was permitted according to regulations. The published NDB/DME 05 approach for Chibougamau/Chapais indicates an inbound course of 051° magnetic whereas the runway's orientation is 045° magnetic. This difference of six degrees means that the aircraft would not be directly in line with the runway centreline on final. The crew therefore had to expect to realign the aircraft with the runway centreline before landing.

The RNAV (GNSS) 05 approach made by the other aircraft, Propair 102, shows that a course of 046° magnetic and an MDA was established at 1760 feet asl, or 492 feet agl. Although this approach is considered a non-precision approach, like the NDB/DME approach, using a GPS and the approach design offer greater precision for alignment with the runway centreline. The crew of Propair 102 benefited from this and the aircraft landed without difficulty on Runway 05 about seven minutes after the go-around by CRQ 501.

The company's SOPs state that during an instrument approach, the PNF must visually scan the instruments and advise the PF of any deviations in:

- speed;
- altitude;
- rate of descent; and
- inbound track.

In addition, during an instrument approach, the PNF must make the calls at 100 feet above the following published altitudes:

- sector altitude;
- procedure turn altitude;
- FAF crossing altitude; and
- MDA.

Calls must also be made at 1000 and 500 feet agl. Even though the pilots were familiar with the mandatory callouts required by the SOPs and had received training on this, none of these callouts were made during the two approaches.

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[11] CAR 602.98 (1).

The company's operations manual states that a missed approach or a go-around must be done when the aircraft is not stabilized at the FAF or 5 nm on final approach or below 1000 feet agl. Among other things, a stabilized approach requires a rate of descent not exceeding 500 feet per minute.

For the second approach, the crew decided to perform a PICMA procedure. This type of approach was developed to increase safety in the approach-and-landing phase. During this type of approach, the co-pilot flies and the pilot-in-command monitors the general situation. Upon approaching the MDA, the pilot-in-command adds exterior scanning to the visual scan of the instruments. If the pilot-in-command decides that a safe landing can be made, he places his hands on the throttle and pushes the co-pilot's hands, saying "landing" and "I have control." The co-pilot continues to visually scan the instruments and advises if there are any deviations. In this accident, once the runway was in sight, the co-pilot transferred the controls to the pilot-in-command who accepted and continued the approach.

At this point, the aircraft was a little less than 500 feet agl, at 0.66 nm from the threshold of Runway 05. This represents an approach slope of about 6° or almost double that of a normal approach slope. The operations manual states that when landing on a runway of 5000 feet or less, touchdown must be done within the first 300 feet. For runways longer than 5000 feet, touchdown can be done within a distance that does not exceed the first 300 feet of the remaining 5000 feet of runway. This means that for Chibougamau/Chapais airport, touchdown can be done up to a distance not exceeding 1796 feet from the runway threshold. To do this, a descent slope of a little more than 4° is required. The investigation could not determine the PF's intended touchdown point. For either scenario, a rate of descent greater than 500 feet per minute was required.

Approach-and-Landing Accidents

Over the last few years, the Flight Safety Foundation (FSF) has made efforts to prevent two major causes of fatal accidents in commercial aviation: controlled flight into terrain (CFIT) and approach-and-landing accidents (ALAs). A FSF task force [12] was created and is responsible for reducing ALAs. The task force concluded, among other things, that rushed and unstable approaches are contributing factors in ALAs. They also determined that failing to recognize the need for go-arounds was a major cause of ALAs.

The CFIT Task Force of the International Civil Aviation Organization acknowledged the need to establish a stable approach during non-precision approaches as a way to prevent CFIT accidents. Although this accident does not meet the criteria of a CFIT, the fact remains that a stable approach reduces the risk of ALAs.

To minimize the vertical manoeuvres required to carry out most non-precision approaches between the moment of the final approach segment and the moment of touchdown, a stabilized constant descent angle (SCDA) non-precision approach (NPA) was established. To conduct an

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12 Flight Safety Foundation Approach-and-Landing Accident Reduction (ALAR) task force.

SCDA NPA, the air operator must be authorized through an operation specification indicated on the operations certificate. This type of approach authorization is not common for aircraft operators governed by Subpart 703 of the CARs. No specification in this respect was indicated on Air Creebec's operations certificate. Consequently, the flight crew could not use this type of approach.

On-board Equipment

The Beechcraft A100 was equipped with two GPS units, models KLN 90B and GARMIN 430. Both GPSs can be used for making non-precision instrument approaches. However, their use was not authorized for IFR approaches because the company's operations certificate did not have any specification in this regard. The certification process was in progress with Transport Canada; at that time, the crew had not been trained to use the GPS units.

The aircraft was equipped with a KGP 560 enhanced ground proximity warning system (EGPWS). When the EGPWS detects a conflict with the terrain or an obstacle, it emits an audible warning or an audible and visual warning for correction. The EGPWS signals different warnings:

- excessive descent rate;
- excessive terrain closure rate;
- altitude loss after takeoff or go-around procedure;
- insufficient terrain clearance;
- excessive deviation below glideslope; and
- 500 feet above airport elevation.

In this occurrence, none of these warnings were activated. Nevertheless, an automatic announcement should have activated when the aircraft reached 500 feet agl. Two reasons could explain why this warning was not activated: either the system was defective or it had been deactivated. The information gathered indicates that the system operated normally in previous flights. It is therefore plausible to believe that the system had been deactivated. However, the investigation could not determine when, why, or by whom it would have been deactivated. According to the EGPWS pilot's guide, the system should be checked before departure. However, the standard checklist used by the crew made no reference to the EGPWS. Consequently, nothing indicated to the flight crew that they must check the EGPWS and ensure that it was properly activated before departure.

Neither of the two aircraft was equipped with an airborne collision avoidance system (ACAS); this was not required by regulations. The aircraft was equipped with an angle of attack sensor on the left wing that activated a stall warning horn in the cockpit when the aircraft reached a speed of 4 to 8 knots above the stall speed. The stall warning system had been calibrated on 17 September 2007 and a flight test had confirmed that it was operating normally.

The aircraft's stall speed for its estimated weight at the time of the accident, which was 10 434 pounds, was 71 knots with level wings, zero thrust, and with landing gear and flaps extended. An aircraft's weight and load factor have an influence on its stall speed. For instance,

when banking, the load factor increases according to the bank angle. Consequently, the greater the bank, the higher the stall speed. The tables below show the stall speeds for the Beechcraft A100 and the DHC-6, the type of aircraft previously flown by the pilot-in-command.

Beechcraft A100: Stall speed in knots without thrust, flaps, and landing gear extended.					
Gross weight 10 434 pounds	Bank angle				
	0°	30°	40°	50°	60°
Stall speed	71	76	81	88	100

DHC-6: Stall speed in knots without thrust, flaps, and landing gear extended.					
Gross weight 10 434 pounds	Bank angle				
	0°	30°	40°	50°	60°
Stall speed	53	58	61	67	75

According to the SOPs, stall recovery must be initiated as soon as the stall warning horn sounds or as soon as buffeting is felt, whichever comes first. The technique consists of reducing the pitch, levelling the wings, applying full power, and setting the flaps to the approach position if they were set at greater than approach. The landing gear is raised when the rate of climb is positive.

In this occurrence, the aircraft disappeared from the radar screen at about 400 feet agl. The horn sounded five seconds before impact. Thrust was increased when the horn sounded. However, the wings were not levelled. The flaps and landing gear remained fully extended until impact.

Analysis

The primary role of a crew is to effectively control the risks relating to a flight. Crew coordination and SOPs are the tools most readily available for controlling threats, errors, and undesirable conditions. Although the company had applicable SOPs and the crew had been trained in accordance with regulations, these tools were not enough to mitigate the risk associated with an unstabilized approach.

In this occurrence, a series of actions and decisions made by the crew gradually increased the risk to which the flight was exposed until the aircraft reached a point where it was impossible to re-establish the safety of the flight. Consequently, this analysis will concentrate on the actions and decisions of the crew and the manner in which they served to bypass the defence mechanisms put in place to reduce the risks related to operation.

The company had provided the crew with all training required by regulations and both pilots had successfully passed their PPCs. However, a PPC is a very limited view at a given moment and therefore does not cover all aspects of an IFR flight. Considering the pilot shortage, it can be

expected that pilots who join a company may have relatively little experience. Because of this, companies need to consider greater monitoring of their knowledge of basic IFR procedures through more detailed SOPs and a training program.

Despite limited IFR experience and experience working in a multiple crew environment, the two pilots were paired. Nothing in the CARs prohibits this. Although the crew had received CRM training, it still had little multiple crew experience and consequently little experience in applying the basic CRM principles. In this occurrence, shortcomings in the areas of communication, workload management, and situational awareness all contributed to increasing the risk of an accident.

The 165 CADORS incidents related to non-compliance with communication procedures in MF areas in Canada indicate that the procedures are either not well known or poorly understood by a number of pilots. In order to improve safety significantly, it is essential that pilots actively monitor the MF and that they follow the reporting procedures specified for use when flying in a MF area.

Propair 102 reported five times that it would proceed for Runway 05. But at no time did the crew of CRQ 501 note this fact. Twice, the crew could not be informed because they had not tuned the MF in a timely manner. The three other Propair 102 transmissions were broadcast on the frequency tuned by the CRQ 501 crew. Everything suggests that their high workload could have contributed to reducing their auditory attention to the radio transmissions made by Propair 102.

When the Québec FIC wanted to ensure that the crew had clearly received the message from Propair 102 after its position report at 10 miles on final for Runway 05, the message did not include the runway number. Subsequently, when Propair 102 reported at 1.5 miles on final, they did not mention the runway number. Transmitting clear, precise, and complete information is important to ensure a good understanding of the situation by those receiving the information. In this case, the information was incomplete and did not allow the CRQ 501 crew to determine the exact position of the other aircraft. This fact, like the non-compliance in communications, did not contribute to the accident. However, it did create a situation in which the pilots of both aircraft did not have good knowledge of their respective positions. In fact, the flight crew of CRQ 501 believed until the end that the other aircraft was approaching on the opposite runway.

It is difficult to understand why the crew of CRQ 501 established itself on final without knowing the exact position of the other aircraft. It was risky to start the final approach believing that the other aircraft was in the opposite direction. Had the other aircraft done a go-around, there would have been a risk of collision. Having an ACAS on board both aircraft would have allowed the pilots to know their positions better in relation to each other and thereby reduce the risk of collision. The crew's high workload, combined with their level of experience, could have contributed to the deficiencies in radio communications.

The presence of GPS equipment and knowledge of its extreme accuracy in approaches may have prompted the crew to attempt to use it despite the absence of certification and training. The time spent programming the GPS reduced the time available to manage the flight such that, on the first approach, the crew did not make the required radio transmissions on the MF, did not activate the ARCAL, missed the verbal calls specified in the SOPs manual, and configured

the aircraft for the approach and landing late. The first approach had been carried out with greater accuracy; the aircraft was closer to the runway's centreline. Consequently, the turns required to realign the aircraft with the centreline would have been less pronounced, thereby reducing the risk of stalling. However, the lighting was off and this could have contributed to the delay in seeing the runway and its environment, thus making a go-around necessary.

The decision to do a second approach was in itself a justified operational decision. There was enough fuel and the crew had seen the runway, which made it plausible to believe the second attempt would be successful. The crew had decided to do a PICMA procedure. Although this type of approach was developed to increase safety in the approach-and-landing phase, it did not help to avoid the accident. This procedure requires calls by the PNF when the aircraft deviates from pre-established acceptable tolerances such as altitude, speed, rate of descent, and course. However, no call is required concerning a limit in bank angle. Furthermore, the control transfer procedure was not carried out as set out in the SOPs and could have taken the pilot-in-command by surprise, leaving little time to choose the best option.

In both approaches, the aircraft was configured late or after it had passed the FAF, contrary to the SOPs. The workload of the PNF was increased and the PNF's attention was focused on tasks that should have been completed before the FAF. As a result, several verbal calls and radio communications were not done.

The CHIBOO beacon was not the FAF for Runway 05. This could have caused confusion regarding the altitude at which it was permissible to descend. Consequently, on its return for a second approach, the flight crew did a race-track pattern using the CHIBOO beacon and descended to 400 feet below the safe obstacle clearance altitude, increasing the risk of a CFIT. In addition, the risk of conflict with the other aircraft was increased because the crew of the other aircraft expected the published altitudes to be followed. As a result, the two aircraft passed abeam in opposite directions with a distance of 1000 vertical feet and a horizontal distance of 3.1 nm between them without either crew being aware of this fact.

Because the outbound time was calculated from the time the aircraft passed abeam the beacon, the aircraft's distance in relation to the runway was reduced when it turned onto the inbound segment. As a result, the aircraft was established on final at less than one mile from the FAF without being configured for the approach. The crew's limited IFR experience could have contributed to poor interpretation of the IFR procedures, in particular regarding how to carry out a race-track pattern.

In general, the training provided by companies does not cover the basic elements of instrument flight because it is assumed that once instrument flight qualifications have been obtained, the pilots are qualified. Training is generally focused on the accuracy of carrying out instrument approach procedures to prepare the candidate for the flight test.

Although this accident does not meet the criteria of a CFIT, it nonetheless remains that a SCDA NPA would have provided additional defence. It is important that crew training be supplemented by clear and precise policies and directives on the characteristics of a stabilized approach and the need to carry out a missed approach if not stabilized.

The investigation could not determine the touchdown point intended by the PF. Nevertheless, when the crew saw the runway, their position required a rate of descent greater than 500 feet per minute and a steep turn at a low altitude in order to line the aircraft up with the runway centreline. The PF put the aircraft in an unstable approach condition for the runway and did not recognize the need for another go-around.

The reason why the pilot-in-command followed through with the landing remains unknown. However, the following factors may have influenced his decision:

- The flight was three hours late and performing a third approach or heading to the alternate airport would have caused further delay; and
- The co-pilot's transfer of control to the pilot-in-command may have been unexpected, leaving the pilot-in-command little time to make a decision. This situation increased the pilot-in-command's stress level.

It is recognized that in a stressful situation, people have a tendency to refer to familiar or automatic actions and behaviour. It is possible that the pilot-in-command carried out actions he had previously done on the DHC-6, on which he had accumulated 80 per cent of his last 655 flying hours. The DHC-6 is more manoeuvrable at lower speeds and its stall speeds are significantly lower than those of a Beechcraft A100. With the DHC-6, lining up with the runway would have required a lower bank angle during the last turn.

A low-altitude turn is a dangerous manoeuvre that requires the pilot flying to be very attentive. In the case of this accident, a right turn was necessary to take the aircraft towards the runway and a high rate of descent was required. The surface wind was 260° at 6 knots. Consequently, the aircraft's ground speed increased after the right turn and, in the left turn, the aircraft drifted to the outside of the turn and moved away from the runway centreline. It is very likely that the pilot-in-command increased the bank to correct the drift. During the turn, to reduce the rate of descent, the pilot-in-command pulled on the controls, which increased the load factor and as a result the stall speed. Because the stall warning horn is adjusted to activate at 4 to 8 knots before a stall and it activated at 100 knots, it can be concluded that the stall speed was between 92 and 96 knots and that the bank angle was greater than 50°.

Taking into account the rate of descent, angle of impact, and the time between activation of the horn and the impact, it was established that the aircraft was less than 100 feet agl when the stall warning sounded. The aircraft stalled at an altitude that did not allow the pilot to complete the stall recovery procedure.

Findings as to Causes and Contributing Factors

1. The aircraft was configured late for the approach, resulting in an unstable approach condition.

2. The pilot flying carried out a steep turn at a low altitude, thereby increasing the load factor. Consequently, the aircraft stalled at an altitude that was too low to allow the pilot to carry out a stall recovery procedure.

Findings as to Risk

1. The time spent programming the global positioning system reduced the time available to manage the flight. Consequently, the crew did not make the required radio communications on the mandatory frequency, did not activate the aircraft radio control of aerodrome lighting (ARCAL), did not make the verbal calls specified in the standard operating procedures (SOPs), and configured the aircraft for the approach and landing too late.

2. During the second approach, the aircraft did a race-track pattern and descended below the safe obstacle clearance altitude, thereby increasing the risk of a controlled flight into terrain. The crew's limited instrument flight rules (IFR) experience could have contributed to poor interpretation of the IFR procedures.

3. Non-compliance with communications procedures in a mandatory frequency area created a situation in which the pilots of both aircraft had poor knowledge of their respective positions, thereby increasing the risk of collision.

4. The pilot-in-command monitored approach (PICMA) procedure requires calls by the pilot not flying when the aircraft deviates from pre-established acceptable tolerances. However, no call is required to warn the pilot flying of an approaching steep bank.

5. The transfer of controls was not carried out as required by the PICMA procedure described in the SOPs. The transfer of controls at the co-pilot's request could have taken the pilot-in-command by surprise, leaving little time to choose the best option.

6. Despite their limited amount of IFR experience in a multiple crew working environment, the two pilots were paired. Nothing prohibited this. Although the crew had received crew resource management (CRM) training, it still had little multiple crew experience and consequently little experience in applying the basic principles of CRM.

Other Findings

1. The emergency locator transmitter (ELT) had activated after the impact but due to circuit board damage its transmission power was severely limited. This situation could have had serious consequences had there been any survivors.

2. The Chibougamau/Chapais airport does not have an aircraft rescue and firefighting service. Because the fire station is 23 kilometres from the airport, the firefighters arrived at the scene 26 minutes after the accident.

3. Although this accident does not meet the criteria of a controlled flight into terrain (CFIT), it nonetheless remains that a stabilized constant descent angle (SCDA) non-precision approach (NPA) would have provided an added defence tool to supplement the SOPs.

4. After the late call within the mandatory frequency (MF) area, the specialist at the Québec flight information centre asked the crew about its familiarity with the MF area while the aircraft was in a critical phase of the first approach, which was approaching the minimum descent altitude (MDA). This situation could have distracted the flight crew while they completed important tasks.

5. The standard checklist used by the flight crew made no reference to the enhanced ground proximity warning system (EGPWS). Therefore, the crew was not prompted to check it to ensure that it was properly activated before departure.

Safety Action

Action Taken

On 22 November 2007, Air Creebec signed a service agreement with an external firm to provide the crews of the Beechcraft A100 and Embraer 110 with additional training on a flight simulator. During this training, the crew resource management principles would be reviewed and integrated into the simulated flight scenarios. A general review of instrument flight rules and procedures, operating procedures in uncontrolled airspace, and compliance with standard operating procedures (SOPs) will be integral parts of the training.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 07 October 2008.

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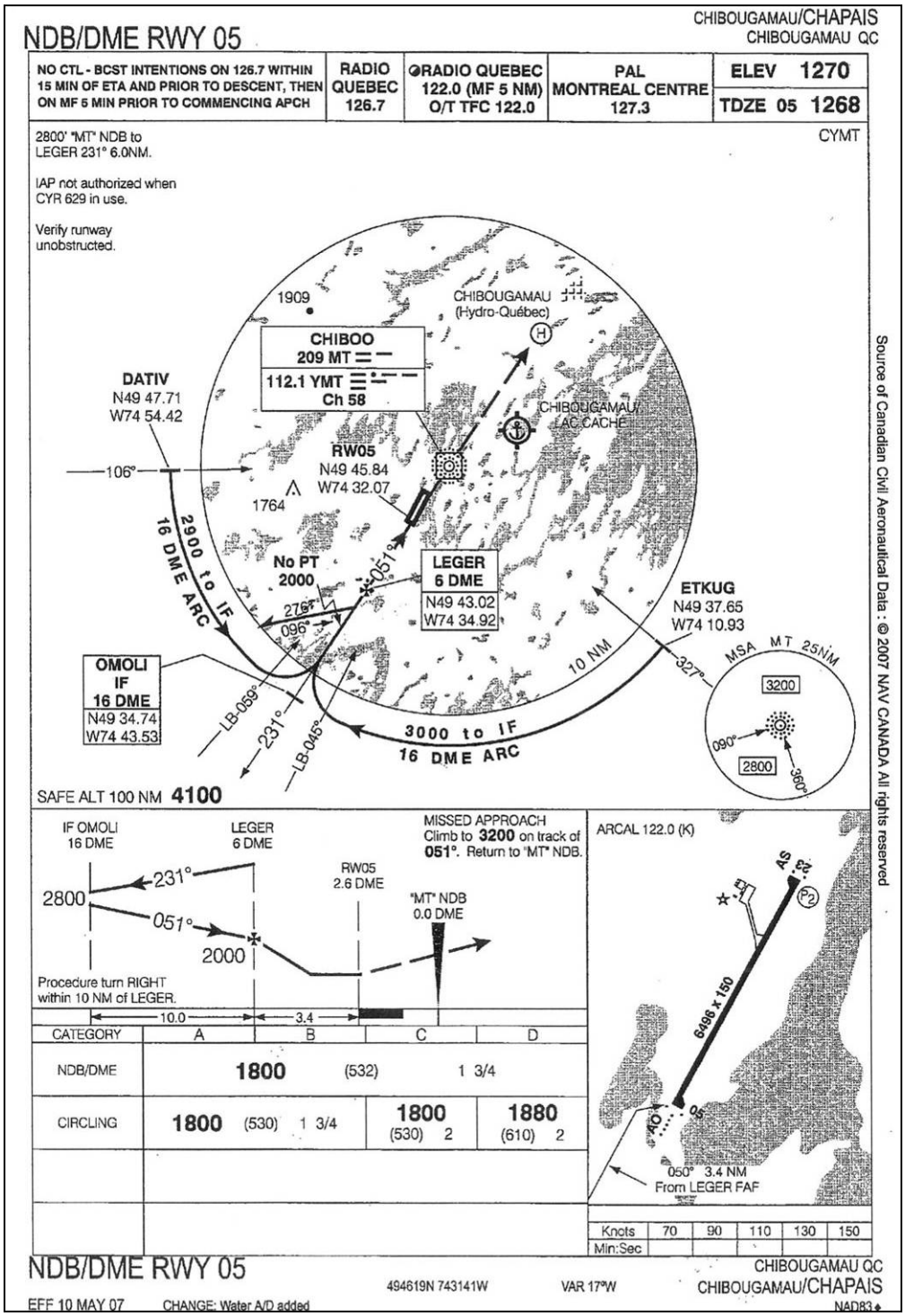
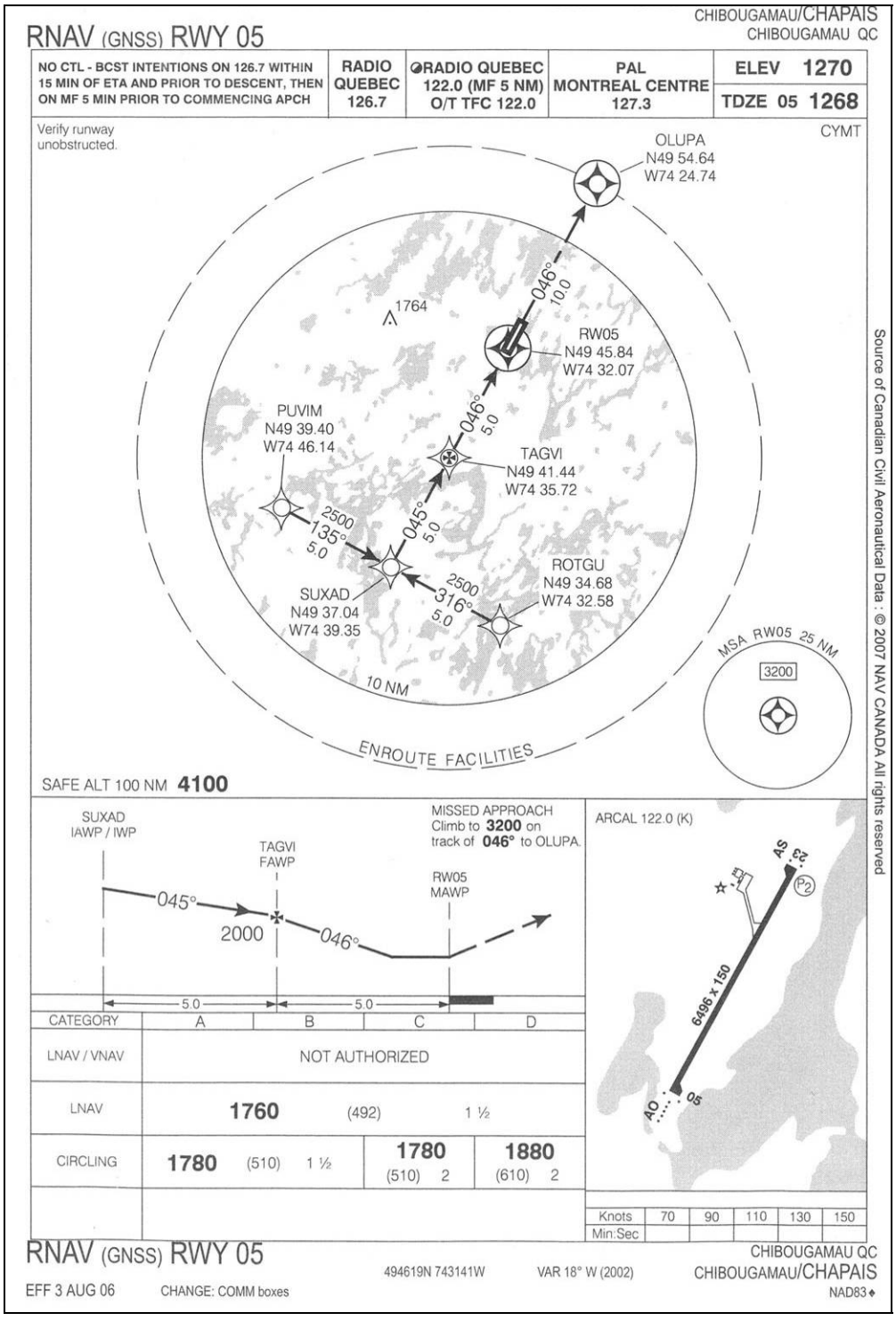
Appendix A – NDB/DME RWY 05 approach for Chibougamau/Chapais



Appendix B – RNAV (GNSS) RWY 05 approach for Chibougamau/Chapais



Appendix C – Glossary

ADF	automatic direction finder
agl	above ground level
ACAS	airborne collision avoidance system
AIRMET	meteorological advisory for flying personnel
ALA	approach-and-landing accident
ARCAL	aircraft radio control of aerodrome lighting
ARFF service	aircraft rescue and firefighting service
asl	above sea level
CADORS	civil aviation daily occurrence reporting system
CARs	*Canadian Aviation Regulations*
CFIT	controlled flight into terrain
CRM	crew resource management
CVR	cockpit voice recorder
DME	distance measuring equipment
EGPWS	enhanced ground proximity warning system
ELT	emergency locator transmitter
FAF	final approach fix
FIC	Flight Information Centre
FSF	Flight Safety Foundation
GFA	graphic forecast area
GNSS	global navigation satellite system
GPS	global positioning system
IFR	instrument flight rules
M	magnetic
MDA	minimum descent altitude
METAR	aviation routine weather report
MF	mandatory frequency
MSA	minimum sector altitude
NDB	non-directional beacon
nm	nautical mile
NOTAM	notice to airmen
NPA	non-precision approach
PF	pilot flying
PICMA	pilot-in-command monitored approach
PNF	pilot not flying
PPC	pilot proficiency check
SCDA	stabilized constant descent angle
SOPs	standard operating procedures
VFR	visual flight rules
°C	° Celsius