Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

# AVIATION INVESTIGATION REPORT
# A11C0102

# RUNWAY OVERRUN
# BEAVER AIR SERVICES LIMITED PARTNERSHIP
# (MISSINIPPI AIRWAYS)
# CESSNA 208B, C-FMCB
# PUKATAWAGAN, MANITOBA
# 04 JULY 2011

Canada

# Aviation Investigation Report

# Runway Overrun

# Beaver Air Services Limited Partnership (Missinippi Airways) Cessna 208B, C-FMCB Pukatawagan, Manitoba 04 July 2011

# Report Number A11C0102

## *Synopsis*

The Beaver Air Services Limited Partnership Cessna 208B (registration C-FMCB serial number 208B1114), operated by its general partner Missinippi Management Ltd (Missinippi Airways), was departing Pukatawagan, Manitoba, for The Pas/Grace Lake Airport, Manitoba. At approximately 1610 Central Daylight Time, the pilot began the takeoff roll from Runway 33. The aircraft did not become fully airborne, and the pilot rejected the takeoff. The pilot applied reverse propeller thrust and braking, but the aircraft departed the end of the runway and continued down an embankment into a ravine. A post-crash fire ensued. One of the passengers was fatally injured; the pilot and the 7 other passengers egressed from the aircraft with minor injuries. The aircraft was destroyed. The emergency locator transmitter did not activate.

*Ce rapport est également disponible en français.*

# Factual Information

## History of the Flight

The aircraft was on the return leg of a daily scheduled flight from The Pas/Grace Lake, Manitoba Airport (CJR3) to the Pukatawagan Airport (CZFG). The flight, which departed at 1500, [1] from CJR3 to CZFG was uneventful. Shortly after arrival, the passengers deplaned. The passengers destined for CJR3 then boarded the aircraft for the return flight.

The pilot entered the aircraft and provided the passengers with a short safety briefing. During the briefing, some passengers were engaged in other activities such as stowing their personal belongings and fastening their seat belts. After entering the cockpit, the pilot started the engine, completed the pre-takeoff checks, broadcast a traffic advisory, and backtracked for departure on Runway 33. The aircraft turned in the turning bay and the pilot advanced power for a rolling takeoff from the beginning of the runway.

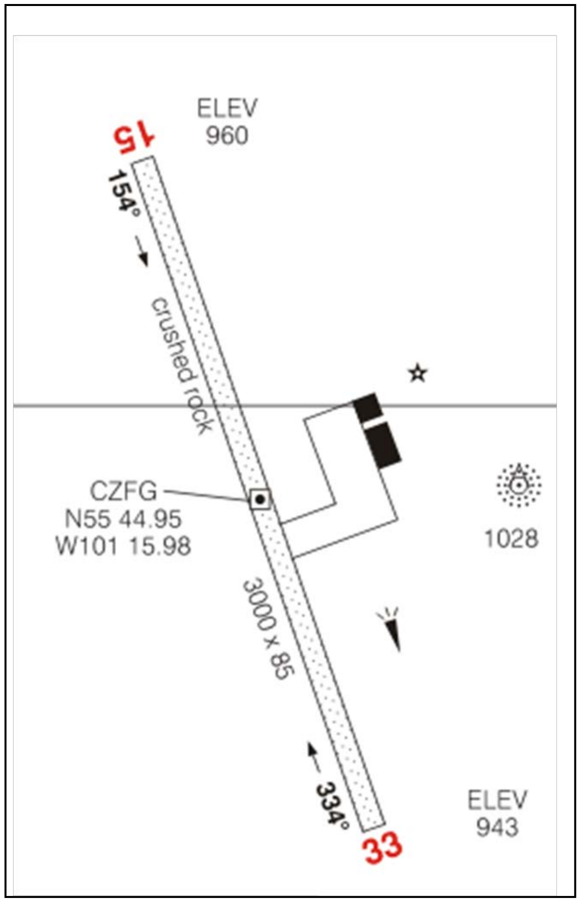


**Figure 1.** Pukatawagan Aerodrome diagram (Source: NAV CANADA, *Canada Air Pilot*, Effective 10 April to 29 July, 2011)

During the takeoff run, the aircraft's airspeed indicator initially rose as the aircraft accelerated and its nose wheel lifted off the runway. The flaps were set to 20° and the engine produced rated power. During the takeoff roll, the aircraft encountered several soft spots near the taxiway intersection (Figure 1). The pilot applied rearward pressure on the control yoke and one or both main wheels briefly lifted off the runway, but the airspeed stopped increasing and the aircraft did not remain airborne. The pilot rejected the takeoff with an estimated 600 feet of runway remaining. The pilot selected engine power to idle, reverse propeller thrust, and flaps to 0° to maximize braking traction. The aircraft continued past the end of Runway 33. The aircraft was travelling at a relatively low speed but the pilot was unable to stop before the aircraft dropped off the steep slope and proceeded down an embankment before coming to rest in a ravine (Photo 1). The aircraft encountered rocks and a sharp slope reversal at the bottom of the ravine. Several of the occupants were injured by the sudden stop. As a result of the impact, the aircraft was damaged and its fuel system was compromised. A

1 All times Central Daylight Time (Coordinated Universal Time minus 5 hours).

post-crash fire ensued almost immediately and consumed most of the aircraft. One of the passengers injured in the accident died because of smoke inhalation due to the post-crash fire.

**Photo 1.** Accident site, looking back at the end of Runway 33 (Pukatawagan Airport)

## *Evacuation*

Passengers seated toward the rear of the aircraft had difficulty opening the aircraft's rear cabin exit door. After several attempts by different passengers, they were successful and were able to escape the wreckage. The front right seat passenger assisted the pilot, who was initially trapped in the seat. That passenger also assisted the front left seat passenger who was injured to the head during the impact and was unconscious. The pilot and front right seat passenger then attempted to extricate the unconscious front left seat passenger, but the fire progressed rapidly and the resulting heat and smoke forced them to discontinue and leave the burning aircraft. The aircraft's passenger seating arrangement and exit locations are depicted in Appendix A. The surviving occupants made their way up the embankment and then to the airport terminal building. Airport workers arrived in vehicles and assisted some of the surviving occupants. The survivors were taken to the nursing station for medical attention, and later evacuated by aircraft to The Pas/Grace Lake. The Pukatawagan Fire Department attended the site and the fire was extinguished at approximately 1645.

## *Pilot Information*

The pilot was certified and qualified for the flight in accordance with existing regulations. He had been employed by Missinippi Airways since March 2010, and had accumulated about 1900 total flight hours, with about 400 flight hours on the Cessna 208B aircraft type. The captain's flight and duty time limits were not exceeded. There was no indication that the pilot was fatigued.

A review of the training records indicated that the pilot's training complied with the requirements of the approved company training manual. This training included, in part, flight and duty time requirements, aircraft instrument and equipment requirements, weather, surface contamination, passenger and cabin safety, and emergency procedures.

The pilot had been into CZFG on numerous occasions in the past. This was the occurrence pilot's third flight into CZFG on the day of the occurrence. The previous flights that day had been conducted using a different aircraft type.

## *Aircraft Information*

The Cessna 208B is a high-wing, fixed gear aircraft equipped with a Pratt & Whitney Canada PT6A-114A turboprop engine. The accident aircraft was manufactured in 2005 and was equipped with a cargo pod, and had been modified with a Transport Canada approved kit to increase the maximum allowable takeoff weight to 9062 pounds. The aircraft had about 900 pounds of fuel on board at takeoff, and the payload consisted of 8 passengers and their baggage. Damage to the aircraft precluded weighing of the aircraft load after the accident. However, the investigation determined that the aircraft's gross weight was approximately 8050 pounds on departure and that the centre of gravity was within allowable limits.

The normal liftoff speed of the C208B is 70 knots. Performance information in the aircraft's *Pilot Operating Handbook* (POH) indicated that the takeoff distance, ground roll, at the prevailing temperature [2] and elevation should have been about 1300 feet on a paved, level, dry runway using the short field takeoff technique. According to the POH, the landing distance, ground roll, under the same conditions is about 1000 feet.

The Cessna 208B short field takeoff technique from the POH is as follows:

> Wing flaps - 20°
> Brakes – apply
> Power – set for takeoff
> Annunciators – check
> Brakes – release
> Rotate – 70 knots
> Climb speed – 83 knots

The amplified POH short field technique suggests to use 20° flap, raise the nose when practical and climb out with the tail low and then level the airplane to accelerate to a safe climb speed.

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[2] The investigation determined that the prevailing temperature at Pukatawagan Airport was approximately 25°C.

The Cessna 208B POH does not list a rejected takeoff procedure, but the emergency procedure for engine failure before takeoff specifies:

Power lever – Beta range
Brakes – Apply
Wing flaps - Retract

The performance changes resulting from the runway conditions prevailing at Pukatawagan at the time of occurrence could not be accurately quantified. The Cessna 208B type is certified without published accelerate-stop or accelerate-go distance calculations. However, test data provided by the aircraft manufacturer for takeoff distances with 20° flap at 73 KTAS indicated that a takeoff run on a hard gravel surface would be about 11% longer than that on a paved dry runway. A landing roll would be about 18% longer on a gravel runway. The manufacturer's data, with gravel correction factors, is summarized in Appendix B. According to the aircraft manufacturer, if the POH technique is used as described, under the prevailing conditions and on a hard gravel runway, the aircraft's accelerate-stop distance should have been 2259 feet with flaps 20° set for takeoff and then flaps full during the rejected takeoff. No information was available in the POH for takeoff with flaps 20° and a rejected takeoff with flaps 0°.

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The cockpit-mounted engine power lever allows the pilot to control engine power. It is connected through a linkage to a cam assembly mounted in front of the fuel control unit at the rear of the engine. The bolt attaching the linkage to the power control lever arm assembly was sent to the TSB Laboratory for examination. The attachment bolt's dimensions were taken and the results were found to be consistent with an AN3-14 bolt instead of the specified AN3-16 bolt. An AN3-14 bolt is 0.25 inch shorter than the AN3-16 bolt. There was a spacer (P/N NAS43HT-46) missing from the bolt. The dimension of the spacer is 46/64 inch (0.719 inch) long, and it would not have been possible to install the specified spacer in the occurrence power control assembly on the AN3-14 bolt, as it was too short. Some metal splatter on the adjacent fuel flow transmitter indicated that it was likely that some kind of aluminum spacer, possibly an aluminum washer, had been installed between the two cadmium-plated steel washers found on the lever arm, before the occurrence. This aluminum washer probably melted during the post-crash fire and the molten aluminum dripped and solidified onto the fuel flow transmitter. There was no indication that the power lever arm anomalies affected the operation of the engine or its power control.

## *Short and Soft Field Takeoffs*

The objective of short field takeoff technique is to effect a takeoff from a firm surface in the shortest possible distance. Commonly-accepted techniques include:

- Apply full power before brake release;
- Put controls on neutral during the takeoff run to minimize aerodynamic drag; and
- Rotate as soon as the aircraft is able to fly and accelerate to climb speed in ground effect.

The objective of soft field technique is to effect a takeoff in soft or rough conditions while minimizing damage. Commonly-accepted techniques include:

- Rolling takeoff to minimize propeller damage;
- Using of elevator early to lift the nose wheel and lighten the load on the main wheels with aerodynamic lift;
- Maintaining nose-high attitude until aircraft lifts off the ground;
- Using increased aerodynamic drag inherent in this technique is accepted where takeoff distance permits, in order to achieve liftoff in soft conditions with minimum damage.

Many of the airports from which the company operates have gravel-surfaced runways. The company used the terms soft field and short field takeoff interchangeably. The company considered Pukatawagan to be a short field runway and taught company pilots to use the takeoff technique as described below. Company pilots using this technique did not report performance problems. The procedure taught by the company for these takeoffs consists of:

- Rolling takeoff with gradual application of power
- Using elevator to lighten the weight on the nose wheel
- Lifting the nose wheel off the runway, once airspeed allows
- Rotating and climbing out, at normal departure airspeed

When the nose wheel is lifted from the runway, the aircraft's induced aerodynamic drag would increase during the takeoff roll. The amount of increased drag and resulting increased takeoff distance is not quantified and depends on the degree of rotation and individual pilot technique.

## *Meteorological Information*

There are no routine weather observations available for the Pukatawagan Airport. While the aircraft was being taxied for departure, the windsock indicated a surface wind of about 10 knots, generally westerly and favouring Runway 33, but varying up to 90° in direction.

A special weather observation (SPECI) issued at 1625 for Lynn Lake, Manitoba, 67 nautical miles (nm) north of Pukatawagan, was as follows: wind 230° true (T) at 5 knots, wind direction varying from 220°T to 290°T, visibility 9 statute miles (sm), scattered cloud based at 7600 feet above ground level (agl), broken cloud ceiling based at 9300 feet agl, temperature 16°C, dew point 13°C, with distant lightning observed to the southeast.

The observed weather at 1600 for Flin Flon, Manitoba, 65 nm southwest of Pukatawagan, was as follows: wind 280°T at 12 knots gusting to 22 knots, visibility 15 sm, scattered cloud based at 5500 feet agl, temperature 25°C, dew point 8°C. The investigation determined that the weather conditions at Pukatawagan at the time of the occurrence were similar to those at Flin Flon.

The area forecast indicated that the area was under the influence of an upper low pressure system over northern Saskatchewan, supporting a surface low pressure system centered just north of Stony Rapids, Saskatchewan. A meteorological assessment carried out by Environment Canada concluded that a moderate westerly pressure gradient and convectively unstable environment across northwestern Manitoba resulted in moderate westerly surface winds with gusts in the 18-22 knot range throughout the afternoon on 04 July 2011. In addition, it had been raining considerably at the Pukatawagan Airport in the last 2 days before the occurrence. . Satellite imagery around the time of the incident shows evidence of an outflow boundary from a thunderstorm cell to the north of Pukatawagan moving through the aerodrome in the 1600 to

1630 time frame. This outflow boundary had the potential to produce an abrupt onset of northwesterly wind gusts as strong as 40 knots and the possibility of wind shear. The possibility of a dry microburst associated with the weaker convective cloud that was observed moving along the outflow boundary was also considered. In the event of a dry microburst near the aerodrome, it has been approximated that brief surface wind gusts on the order of 60 knots was a possibility. It is important to point out that while the potential had been identified, the probability of a significant dry microburst was considered low and there is no indication that a dry microburst occurred.

## *Aerodrome Information*

The Pukatawagan Airport is owned and operated by the Province of Manitoba, Department of Infrastructure and Transportation. It has a single runway (Runway 15/33) that is 3000 feet (approx. 914 m) long by 85 feet (approx. 26 m) wide. A turnaround area is located at each end of the runway. The turnaround area at the end of Runway 33 is 230 feet (approx. 71 m) long. The gravel-surfaced runway was wet at the time of the occurrence, and several ruts from other aircraft tires were visible on the surface of the runway.

Beyond the turnaround area, the prepared surface gives way to an embankment which descends into a ravine. The slope of the embankment is approximately 30° to 45° and is comprised of gravel, rocks, and large boulders. The slope descends about 20 feet vertically, and then reverses sharply into the contour of a ravine.

Transport Canada publication TP 312E entitled *Aerodrome Standards and Recommended Practices* (TP 312E) requires that a runway and any associated stopway shall be included in a runway strip. According to TP 312E, a strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least 60 m where the code number is 2, 3 or 4. The code is intended to provide a method for linking the characteristics of aerodromes with the aeroplanes that are intended to operate there. The code is composed of 2 elements which are related to the aeroplane performance characteristics and dimensions. Element 1 is a number based on the aeroplane reference field length and element 2 is a letter based on the aeroplane wing span and outer main gear wheel base. The Cessna 208B aircraft has a wingspan of 16 m and a main gear wheel span of 3.6 m.

TP 312E references for airport codes 2(b), 3(c), 4(d), and 4(e) are as follows

| Code number | Aerodrome Field Length | Code letter |
|---|---|---|
| 2 | 800 m up to 1200 m | (b) |
| 3 | 1200 m to 1800 m | (c) |
| 4 | 1800 m and over | (d) |
| 4 | 1800 m and over | (e) |

The airport code for the Pukatawagan Airport is 2 (b).

TP 312E also recommends runway end safety areas (RESAs) for some airports:

> A runway end safety area should be provided at each end of a runway strip where the code number is 3 or 4. The runway end safety area should extend from the end of a runway strip for as great a distance as practicable, but at least 90 m. A runway end

> safety area should provide a cleared and graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane undershooting or overrunning the runway. The surface of the ground in the runway end safety area does not need to be prepared to the same quality as the runway strip. The longitudinal slopes of a runway end safety area should not exceed a downward slope of 5 per cent. Longitudinal slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided. The transverse slopes of a runway end safety area should not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes should be as gradual as practicable. A runway end safety area should be so prepared or constructed as to reduce the risk of damage to an aeroplane undershooting or overrunning the runway and facilitate the movement of rescue and fire fighting vehicles.

The Pukatawagan Airport meets the stopway requirement of TP 312 for its currently assigned airport code. However, the Pukatawagan Airport, as well as many other airports with similar sized runways, is often used by much larger aircraft than a Cessna 208B. One example is the Hawker Siddeley HS-748 aircraft type, with a wingspan of 30 m. and a main gear wheel span of 7.6 m. Some other aircraft types including the Cessna 550, Lockheed L188, de Havilland DHC-8 and Douglas DC4 have also operated from Pukatawagan and other airports across northern Ontario and Manitoba. Regardless of the airport code, a RESA would reduce risk to aircraft using the Pukatawagan airport. Although the runway at Pukatawagan was compliant with TP 312E, the topography of the terrain beyond the runway end contributed to aircraft damage and to the injuries to crew and passengers. Harsh runway-end conditions prevail at several other airports in northern Manitoba, in Ontario, and in other areas. For example, both runway ends at St. Theresa Point, Manitoba, descend steeply to a lake. Steep drop-offs are also found at the ends of runway 26 at Kenora, Ontario, runway 27 at Pickle Lake, Ontario, runway 31 at North Spirit Lake, Ontario and runway 18 at Flin Flon, Manitoba.

During the last 10 years, there have been a number of occurrences in which aircraft overran runways in Canada (Appendix C). The occurrences indicate that shorter runway overruns into benign conditions often resulted in few injuries and little or no property damage. Longer overruns into harsh conditions such as the one in Pukatawagan resulted in death or injury, and more property damage. The TSB has identified runway overruns as an issue on its Watchlist, which notes that:

> The TSB has investigated a number of landing accidents and incidents and has identified deficiencies, made findings, and issued safety communications such as runway surface condition reporting requirements and recommendations on runway end safety areas (RESAs). Specifically, in the past 10 years, the TSB has issued 1 recommendation and 4 safety communications on this issue, but more must be done to ensure safe landings. In bad weather, pilots need to receive timely information about runway surface conditions. Airports need to lengthen the safety areas at the end of runways or install other engineered systems and structures to safely stop planes that overrun.

The overrun area for Runway 33 is also the terrain underlying the final approach for Runway 15. An aircraft undershooting an approach for Runway 15 would be faced with the steep slope and rocky ground encountered by the aircraft in this occurrence, but at higher speed and with greater impact forces, leading to a high likelihood of passenger injury and damage to aircraft.

## *Flight Recorders*

There is no regulatory requirement for this type of aircraft to carry any recorders; however, it was equipped with an event recorder designed to record and store certain engine performance parameters for maintenance purposes. This recorder was heavily damaged in the post-crash fire and none of its stored information could be retrieved.

## *Wreckage and Impact Information*

The aircraft was destroyed by impact forces and fire, and examination of the wreckage was limited as a result. However, control continuity was established and one of the main landing gear tires revealed flat-spotting, indicating heavy braking. The flap system was found in the 0° position. Damage to the propeller was considered to have resulted from impact forces and fire. No pre-existing malfunctions or defects were found.

## *Medical and Pathological Information*

The front left seat passenger, seated directly behind the pilot and the bulkhead separating the cabin from the cockpit , was wearing a seatbelt, but was not wearing the available shoulder harness. That passenger was severely injured to the head due to the impact and subsequently died of smoke inhalation.

## *Fire*

Impact forces caused deformation of the aircraft structure which compromised the fuel system. Fuel was released at the rear of the engine, in the vicinity of the aircraft's battery and exhaust system. Both of these items had the capacity to ignite the fuel and a fire resulted almost immediately. The fire was fed by fuel which flowed by gravity from the fuel tanks in the wings. The nose-down attitude of the aircraft in the ravine placed the fire below the aircraft's cabin and the heat and flames therefore moved into the cabin within a short time, limiting the survivable time inside the cabin after the accident.

## *Previous TSB Recommendations*

Post-impact fires have been documented as a risk to aviation safety in previous TSB investigations. As well, following TSB Safety Study SII A05-11 completed in 2006, the TSB concluded that requirements to consider and adapt countermeasures in new aeroplane designs may significantly reduce the risk and incidence of post-impact fires in impact-survivable accidents. Therefore, the Board recommended that:

> To reduce the number of post-impact fires in impact-survivable accidents involving new production aeroplanes weighing less than 5700 kg, Transport Canada, the Federal Aviation Administration, and other foreign regulators include in new aeroplane type design standards: methods to reduce the risk of hot items becoming ignition sources; technology designed to inert the battery and electrical systems at impact to eliminate high-temperature electrical arcing as a potential ignition source; requirements for protective or sacrificial insulating materials in locations that are vulnerable to friction heating and sparking during accidents to eliminate friction

> sparking as a potential ignition source; requirements for fuel system crashworthiness; requirements for fuel tanks to be located as far as possible from the occupied areas of the aircraft and for fuel lines to be routed outside the occupied areas of the aircraft to increase the distance between the occupants and the fuel; and improved standards for exits, restraint systems, and seats to enhance survivability and opportunities for occupant escape. (A06-09, issued 29 August 2006)

Transport Canada (TC) responded to this recommendation in November 2006 and January 2007, but because these responses contain no action or proposed action that will reduce or eliminate the risks associated with this deficiency, the overall response to Recommendation A06-09 was assessed as Unsatisfactory. The Board has determined that as the residual risk associated with the deficiency identified in Recommendation A06-09 is substantial and no further action is planned by TC, continued reassessments will not likely yield further results.

The Board also found that there are a large number of small aircraft already in service and the defences against post-impact fires in impact-survivable accidents involving these aircraft are and will remain inadequate unless countermeasures are introduced to reduce the risk. The most effective ways to prevent post-impact fires in accidents involving existing small aircraft are to eliminate potential ignition sources, such as hot items, high-temperature electrical arcing and friction sparking, and prevent fuel spillage by preserving fuel system integrity in survivable crash conditions. Technology that is known to reduce the incidence of post-impact fires by preventing ignition and containing fuel in crash conditions may be selectively retrofitted to existing small aircraft, including helicopters certified before 1994. Therefore, the Board recommended that:

> To reduce the number of post-impact fires in impact-survivable accidents involving existing production aircraft weighing less than 5700 kg, Transport Canada, the Federal Aviation Administration, and other foreign regulators conduct risk assessments to determine the feasibility of retrofitting aircraft with the following:
>
> - selected technology to eliminate hot items as a potential ignition source;
> - technology designed to inert the battery and electrical systems at impact to eliminate high-temperature electrical arcing as a potential ignition source;
> - protective or sacrificial insulating materials in locations that are vulnerable to friction heating and sparking during accidents to eliminate friction sparking as a potential ignition source; and
> - selected fuel system crashworthiness components that retain fuel.
>
> (A06-10, issued 29 August 2006)

TC responded to these recommendations in November 2006 and January 2007, but because these responses contained no action or proposed action that would reduce or eliminate the risks associated with this deficiency, TC's overall response to Recommendation A06-10 was assessed as Unsatisfactory. The Board has determined that as the residual risk associated with the deficiency identified in Recommendation A06-10 is substantial and that no further action is planned by TC, continued reassessments will not likely yield further results.

The following TSB Laboratory report was completed:

LP 113/2011 - Analysis of Power Lever Hardware

This report is available from the TSB upon request.

# *Analysis*

There was no indication that an aircraft system malfunction contributed to this occurrence. As a result, the analysis will focus on airport runway conditions, pilot technique and the decision to reject the takeoff, and the potential impact that environmental factors played in this occurrence. In addition, risks associated with overruns and passenger survivability will be analyzed with the objective of improving aviation safety.

The runway conditions at the Pukatawagan Airport had been adversely affected by recent rains. The rain caused some soft spots to form on the gravel-surfaced runway, most notably in the area near the taxiway intersection. However, these conditions would also have been present during the pilot's previous operations at the airport on the day of the accident, albeit with a different aircraft type. No problems were noted during the pilot's previous flights into CZFG, and no problems were reported by other aircraft operating in and out of CZFG on the day of the occurrence. The wet, soft gravel-surfaced runway condition impeded the aircraft's ability to reach its required liftoff airspeed.

The pilot used the takeoff technique taught by the company. The technique used increased drag during the takeoff roll; however, the effect could not be quantified. The fact that the procedure had been in use for some time by the company suggests that performance decrements were likely small and could not be considered determinative. However, in this occurrence, one or both of the main landing gear wheels lifted off the ground momentarily but the aircraft was unable to fly away. This indicates that either the aircraft was rotated too early or a significant degree of rotation occurred before liftoff speed was attained. Either way, a significant amount of additional drag was incurred during the takeoff roll.

Weather analysis indicated that scattered to broken cloud with gusty winds predominated the area, with moderate gusty winds and occasional unstable convective activity with the possibility of wind shear. The weather conditions at the Pukatawagan Airport were not recorded, and there were no reliable indicators except the windsock.

The aircraft's airspeed stopped increasing during the takeoff roll. This could have been caused by extra dragging, the soft runway or an unexpected wind shift or wind shear which would have been detrimental to takeoff performance. It is unknown whether those conditions would have affected the entire takeoff roll, had it not been rejected or whether they would have precluded a successful takeoff, had it been continued. Airmanship dictates that a pilot decides whether to abandon a takeoff while there is still room to stop on the remaining runway. The lack of accelerate stop distance information for the aircraft impedes the crew's ability to plan the takeoff-reject point accurately. Although the pilot's decision to reject the takeoff was reasonable, the decision to reject was made at a point from which insufficient runway and turnaround area remained to bring the aircraft to a stop, resulting in the aircraft's departure from the prepared surface.

The aircraft's potential accelerate-stop distance under the prevailing conditions was within the length of the runway under ideal gravel runway conditions using a short field take off technique. The effects of the soft runway, gusty or shifting winds, and the technique used decreased the aircraft's performance so that it consumed a significant portion of the runway length. The decision to reject with less than the required stopping distance remaining made a successful rejected takeoff impossible.

The airport runway had been used successfully for Cessna 208 and other aircraft operations for some time. However, during the runway overrun, the steep 20-foot drop-off and sharp slope reversal contributed to the impact damage that led to the deceased passenger's injuries and the fuel system damage that in turn caused the fire. The aircraft's orientation at the bottom of the slope exacerbated the heat effect and the speed at which the fire spread. The hostile terrain at the end of Runway 33 contributed to the occupants' injuries and fuel system damage that in turn caused the fire. This complicated the passenger evacuation and prevented the rescue of the injured passenger.

Harsh runway-end conditions prevail at several airports across northern Manitoba, Ontario, and other areas. Although the runway at Pukatawagan was compliant with TP 312E, the topography of the terrain beyond the runway end contributed to aircraft damage and to the injuries to crew and passengers.

The pilot's passenger briefing was only partly effective in that some passengers were engaged in other activities and did not assimilate the exit procedure, causing them to have difficulty opening the passenger door during the evacuation. In addition, the deceased passenger was not wearing his shoulder harness, which contributed to the seriousness of his injuries due to the impact when the aircraft reached the bottom of the ravine and ultimately to his death in the post-impact fire.

Previous TSB recommendations A06-09 and A06-10 were issued to reduce the risk of post-impact fire in new production and existing production aeroplanes weighing less than 5700 kg. Responses to these recommendations received from TC have been rated as Unsatisfactory. As a result, there is a continuing risk of post-impact fire in impact-survivable accidents involving these aircraft.

In 2010, TSB published its Watchlist describing the safety problems that pose the greatest risk to Canadians. Among the safety issues identified, TSB noted that data critical to understanding how and why transportation accidents happen are frequently lost, damaged, or not required to be collected. While C-FMCB was equipped with an event recorder, it was not required to be equipped with certified flight recorders. When data recordings are not available to an investigation, this may preclude the identification and communication of safety deficiencies to advance transportation safety.

# *Findings as to Causes and Contributing Factors*

1. Runway conditions, the pilot's takeoff technique, and possible shifting wind conditions combined to reduce the rate of the aircraft's acceleration during the takeoff roll and prevented it from attaining takeoff airspeed.

2. The pilot rejected the takeoff past the point from which a successful rejected takeoff could be completed within the available stopping distance.

3. The steep drop-off and sharp slope reversal at the end of Runway 33 contributed to the occupant injuries and fuel system damage that in turn caused the fire. This complicated passenger evacuation and prevented the rescue of the injured passenger.

4. The deceased passenger was not wearing the available shoulder harness. This contributed to the serious injuries received as a result of the impact when the aircraft reached the bottom of the ravine and ultimately to his death in the post-impact fire.

## *Findings as to Risk*

1. If pilots are not aware of the increased aerodynamic drag during takeoff while using soft-field takeoff techniques they may experience an unexpected reduction in takeoff performance.

2. Incomplete passenger briefings or inattentive passengers increase the risk that they will be unable to carry out critical egress procedures during an aircraft evacuation.

3. When data recordings are not available to an investigation, this may preclude the identification and communication of safety deficiencies to advance transportation safety.

4. Although the runway at Pukatawagan and many other aerodromes are compliant with *Aerodrome Standards and Recommended Practices* (TP 312E), the topography of the terrain beyond the runway ends may increase the likelihood of damage to aircraft and injuries to crew and passengers in the event of an aircraft overrunning or landing short.

5. TC's responses to TSB recommendations for action to reduce the risk of post-impact fires have been rated as Unsatisfactory. As a result, there is a continuing risk of post-impact fires in impact-survivable accidents involving these aircraft.

6. The lack of accelerate stop distance information for aircraft impedes the crew's ability to plan the takeoff-reject point accurately.

## *Other Finding*

1. Several anomalies were found in the engine's power control hardware. There was no indication that these anomalies contributed to the occurrence.

## *Safety Action Taken*

### *Missinippi Airways*

The following has been reviewed with crews

- Pilot takeoff technique- short field/soft field;
- Weather conditions and its effects on flight at Pukatawagan in particular;

- Accelerate/stop parameters;
- Confirmation that passengers wear their seatbelts and shoulder harnesses.

The company has implemented a new short-field take-off procedure that follows the normal take-off procedure in the C208B POH. The company will also have more emphasis on short/soft field take-off/landing procedures in future ground schools for all aircraft types operated.

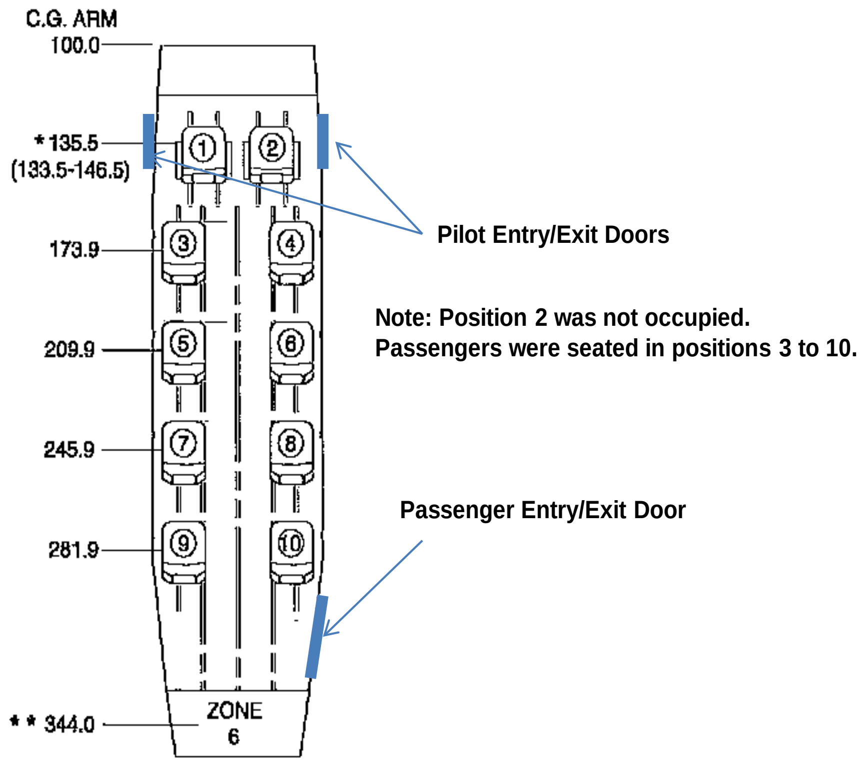
The matter of the engine power control hardware has been addressed through the company quality assurance program and the following action has taken place

- Parts catalogue print outs of engine controls will be installed in each aircraft
- Inspection/task binder for quick reference of parts required
- Where a maintenance action that requires engine removal/ installation, a checklist will be used outlining specific checks to be completed concerning dual inspection and parts usage for engine installation. This form is to be filled out and signed by the person completing the dual inspection.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 09 May 2012.*

*Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.*

## *Appendix A – Cabin Seating Arrangement, Cessna 208B:*




10- PLACE SEATING
(COMMUTER)

# *Appendix B -Performance Results Cessna 208B*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **208B with Pod** | | | | |
| Pressure Altitude | 960 | ft | | | | | |
| Weight | 8000 | lb | | | | | |
| OAT | 25 | °C | | | | | |
| Wind Speed | 13 | kts | | | | | |
| Wind Direction | 290 | | | | | | |
| Runway | 33 | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **Takeoff Ground Roll** | | | | | **Flaps 20°** | | |
| | | | | | 73 | KTAS | |
| Interpolated Ground Roll | | | | | 1258 | ft | |
| HW Correction | 10.0 | kts | | | 1144 | ft | |
| Gravel Correction | 11% | | | | **1270** | **ft** | |
| | | | | | | | |
| | | | | | | | |
| **Landing Ground Roll** | | | **Flaps FULL** | | | | |
| | | | 79 | KTAS | | | |
| Interpolated Ground Roll | | | 922 | ft | | | |
| HW Correction | 10.0 | kts | 839 | ft | | | |
| Gravel Correction | 18% | | **989** | **ft** | | | |
| | | | | | | | |
| | | | | | | | |
| **Total Ground Roll Distance Here:** | | | **2259** | **ft** | | | |

<u>Note</u>: Interpolated ground roll results for takeoff, flaps 20° and landing, flaps full, were obtained based on test results. Results for accelerate-stop, and landing, flaps up, were not available.

# *Appendix C - TSB Data – Runway Overrun Occurrences – January 2002 to May 2011*

| File No. | Date | Location | Overrun area | Aircraft type | Damage | Injuries |
|---|---|---|---|---|---|---|
| A02A0107 | 10/09/2002 | Gander, NL | Displaced threshold | DC-8 | None | None |
| A03W0047 | 07/03/2003 | Fort McMurray, AB | Gravel and snow | Beech 200 | None | Minor |
| A04O0188 | 14/072004 | Ottawa, ON | Grass overrun area | Embraer 145 regional jet | None | None |
| A04O0336 | 16/12/2004 | Oshawa, ON | Overrun area/fence | Shorts SD3-60 | Substantial | Serious |
| A04Q0197 | 23/12/2004 | Sherbrooke, PQ | Overrun area/snow | Falcon 20 | None | None |
| A05A0035 | 15/03/2005 | St. Anthony, NL | Graded, level, gravel surface | Merlin SW4 | None | None |
| A05O0105 | 27/05/2005 | Chapleau, ON | Gravel overrun area | Grumman G-159 Gulfstream | None | None |
| A05H0002 | 02/08/2005 | Toronto, ON | Gully overrun area | Airbus A-340-313 | Destroyed | Serious |
| A05A0102 | 12/08/2005 | Kildare Capes, PEI | Treed overrun area | Beech 19a Musketeer | Substantial | Serious |
| A05O0257 | 15/11/2005 | Hamilton, ON | Overrun area | Gulfstream 100 | None | None |
| A06O0015 | 21/01/2006 | Hamilton, ON | Overrun area | Boeing 707-330b | None | None |
| A06C0117 | 23/07/2006 | Sachigo Lake, ON | Gravel threshold and 300-400 feet of clearway | Hawker Siddeley HS 748 | Minor | None |
| A06Q0190 | 26/11/2006 | Montréal, PQ | 600 feet into overrun area | Learjet 35a | Substantial | None |
| A06W0250 | 29/12/2006 | Carat lake, NU | Overrun area-embankment | Douglas C-54 | Substantial | Minor |
| A07P0008 | 09/01/2007 | Prince George, BC | Overrun area 60 feet/snow | Learjet 25B | Substantial | Minor |
| A07A0029 | 31/05/2007 | Gander, NL | Overrun area 400 feet | Volga Dnepr AN124 | None | None |
| A07C0103 | 15/06/2007 | Red Lake, ON | Gravel overrun/30 feet | Cessna 680 | None | None |
| A07P0340 | 04/10/2007 | Comox, BC | Displaced threshold 500 feet | Boeing 737-700 | None | None |
| A08W0001 | 07/01/2008 | Fort Smith, NT | Runway overrun area 367 feet | BAE Jetstream 3212 | Minor | None |
| A08O0035 | 17/02/2008 | Ottawa, ON | Runway overrun area 200 feet snow | Boeing 737-700 | None | None |
| A08O0333 | 14/12/2008 | North Bay, ON | Runway overrun area 250 feet snow | DeHavilland DHC 8-100 | None | None |
| A09O0176 | 16/08/ 2009 | Sault Ste Marie, ON | Runway overrun area 100 feet | McDonnell Douglas CF-18 | Unknown | None |
| A10C0012 | 22/01/ 2010 | Winnipeg, MB | Runway side | Canadair RJ700 | None | None |
| A10A0032 | 24/03/2010 | Moncton, NB | Runway overrun 40 | Boeing 727-200 | None | None |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | feet mud | | | |
| A10H0004 | 16/06/2010 | Ottawa, ON | Runway overrun 500 feet | Embraer 145 | Minor | Minor |
| A10A0094 | 10/09/2010 | Halifax, NS | Runway overrun area | F86E Sabre Jet | Minor | None |
| A10O0111 | 02/06/2010 | Oshawa, ON | Runway overrun area 233 feet | Fairchild SA-227-AC | None | None |
| A10P0250 | 04/08/2010 | Abbotsford, BC | Closed runway area | Boeing 737-600 | None | None |
| A10C0165 | 15/09/2010 | Steinbach, MB | Runway overrun – ditch | Cessna 182B | Substantial | None |
| A10A0114 | 30/10/2010 | Gander, NL | Runway overrun area | Gulfstream G IV | None | None |
| A10Q0221 | 18/12/2010 | Sanikiluaq, NU | Runway side | Swearingen Metro SA226-TC | Substantial | None |
| A11O0081 | 03/01/2011 | Kincardine, ON | Runway overrun area – trees | Piper PA28 | Substantial | None |
| A11C0020 | 12/02/2011 | Winnipeg, MB | Runway overrun area | Canadair CL-600 RJ | None | None |
| A11C0048 | 03/04/2011 | Kindersley, SK | Runway overrun area 30 feet snow | Cessna 172M | Substantial | None |
| A11C0057 | 18/04/2011 | Steinbach, MB | Runway overrun area – ditch | Cessna 152 | Substantial | None |
| A11C0065 | 29/04/2011 | Shoal Lake, MB | Runway overrun area | Cessna 177B | Substantial | Minor |