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

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A21O0066

RUNWAY OVERRUN

Thunder Airlines Limited
Beechcraft King Air A100, C-GKAJ
Moosonee Airport, Ontario
06 August 2021

History of the flight

On 06 August 2021, the Beechcraft King Air A100 aircraft (registration C-GKAJ, serial number B232) commercially registered to Thunder Airlines Limited (Thunder Airlines) was conducting scheduled flight THU107 from Timmins (Victor M. Power) Airport (CYTS), Ontario, to Moosonee Airport (CYMO), Ontario, with 2 crew members and 7 passengers on board. The flight departed CYTS at 0831.[1]

While the occurrence crew prepared for an approach to Runway 06 at CYMO, another aircraft operated by Thunder Airlines as flight THU106 attempted the first of 2 instrument approaches to Runway 06. Although challenged by the weather, it was able to land on its second approach at 0916.

At the time of the occurrence, there was heavy rain in the vicinity of CYMO. The aircraft conducted its first approach, which was unsuccessful. It then conducted a missed approach at 0922, followed by a second approach, this time for Runway 24. While on short final, the crew was able to acquire the required visual references to continue the approach to land. After touching down at approximately

[1] All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

the midpoint of Runway 24, the aircraft continued along the runway, overran it, and came to a stop approximately 50 feet beyond the threshold of Runway 06 at approximately 0934. There were no injuries and no damage to the aircraft.

Flight crew

The captain, who was the pilot flying (PF), had accumulated approximately 2038 hours total time, including 1773 hours on the Beechcraft King Air A100. The first officer, who was the pilot monitoring, had accumulated approximately 1231 hours total time, 114 hours of which were on the Beechcraft King Air A100.

The occurrence flight crew had valid medical certificates and held the appropriate licences for the flight in accordance with existing regulations.

Weather information

Surface weather observations in an aerodrome routine meteorological report (METAR) are made by human observers or by an automated weather observation system (AWOS). An AWOS is installed at CYMO and, as specified in the *Canada Flight Supplement*, is a METAR AUTO (automatic METAR) system. The METAR AUTO system produces an hourly METAR as well as an aerodrome special meteorological report (SPECI) if the weather changes significantly from the METAR. The AWOS for CYMO is broadcast 24 hours a day on the frequency 124.8 MHz.

Before the flight, the flight crew had reviewed the weather information for the route of flight, which included NOTAMs, graphic area forecasts, METARs, aerodrome forecasts (TAFs), pilot weather reports, AIRMETs, and significant meteorological information. The crew also viewed the available weather cameras for the airports along the planned route of flight.

The following TAF was issued for CYMO on 06 August 2021 at 0739 and covered the period from 0800 to 2000:

- wind direction 220° true (T) at 5 knots
- visibility more than 6 statute miles (SM)
- scattered clouds at 600 feet above ground level (AGL)
- overcast ceiling at 5000 feet AGL
- temporarily between 0800 and 1100, visibility 3 SM in light rain
- broken ceiling at 500 feet AGL
- overcast layer at 5000 feet AGL

The flight crew reviewed the METAR issued at 0800, 36 minutes before departure from CYTS, that stated the following:

- wind direction variable at 2 knots
- visibility 9 SM
- broken ceiling at 300 feet AGL
- overcast layer at 6000 feet AGL
- temperature of 13 °C and dew point of 13 °C
- altimeter setting of 29.73 inches of mercury (inHg)

Before starting the descent for CYMO, the crew listened to the AWOS at CYMO and received the following weather observation taken at 0859:

- winds from 070° magnetic (M) at 3 knots, variable from 030°M to 090°M
- visibility of 5 SM in light rain and mist
- overcast ceiling at 300 feet AGL
- temperature of 13 °C and dew point of 13 °C
- altimeter setting of 29.73 inHg

The flight crew had not received the CYMO SPECI issued at 0918, 4 minutes before the occurrence aircraft conducted its missed approach, that reported the following:

- winds from 070°T at 4 knots, variable from 010°T to 090°T
- visibility of 3 SM in light rain and mist
- broken ceiling at 300 feet AGL and overcast layer at 1400 feet AGL
- temperature of 13 °C and dew point of 13 °C
- altimeter setting of 29.72 inHg

At 0930, approximately 4 minutes before the aircraft touched down on Runway 24, the following CYMO SPECI was issued but not received by the flight crew:

- winds from 010°T at 4 knots, variable from 340°T to 070°T
- visibility of 3 SM in heavy rain and mist
- broken ceiling at 300 feet AGL, a broken layer at 1000 feet AGL, and an overcast layer at 1400 feet AGL
- temperature of 13°C and dew point of 13 °C
- altimeter setting of 29.72 inHg

A review of post-occurrence photographs, taken approximately 20 minutes after the runway overrun, showed that the runway appeared to be very wet and that the rainfall was heavy.

Aircraft information

The investigation did not identify any issues related to aircraft equipment, maintenance, or certification that would have prevented the aircraft from operating normally during the occurrence flight. The aircraft's weight and centre of gravity were within the prescribed limits. At the time of the occurrence, the aircraft had accumulated approximately 35 100 total air time hours.

The occurrence aircraft was not equipped with an anti-skid braking system.

The occurrence aircraft was equipped with a cockpit voice recorder; however, it was not equipped with a flight data recorder, nor was it required to be by regulation.

Aerodrome information

CYMO is located approximately 9.5 nautical miles (NM) upstream from James Bay, adjacent to the north shore of the Moose River, and has an airport elevation of 30 feet above sea level.

CYMO has 2 runways. Runway 06/24, the occurrence runway, is an asphalt runway that is 4004 feet long and 100 feet wide. The second, Runway 14/32, is a combination gravel/asphalt runway that measures 3554 feet long by 100 feet wide (1872 feet gravel, 1682 feet asphalt).

CYMO has 5 published instrument approaches in the *Canada Air Pilot* (CAP): RNAV (GNSS)[2] Rwy (Runway) 06, RNAV (GNSS) Rwy 24, VOR[3] Rwy 06, VOR Rwy 24, and VOR Rwy 32.

Both Runway 06 and Runway 24 had an abbreviated precision approach path indicator (APAPI) installed; however, both APAPIs were reported, by NOTAM, as being unserviceable continuously since 22 November 2019. APAPIs are not required to be operational by regulation.

Flight profile

The flight crew conducted 2 instrument approaches at CYMO. On the first approach, the RNAV (GNSS) Rwy 06, the flight crew did not acquire the required visual reference to continue the descent to land on Runway 06. The second approach to CYMO, the RNAV (GNSS) Rwy 24, was conducted for Runway 24. The localizer performance with vertical guidance (LPV) minima for both approaches are 276 ft above sea level (250 feet AGL), which is the altitude (decision altitude) at which the flight crew must conduct a missed approach if the required visual reference is not acquired, and an advisory visibility of 1 SM. While conducting the second approach, the flight crew was able to acquire the required visual reference at approximately ½ NM on final for Runway 24 and continued the descent to landing.

During the descent, while transitioning from instrument meteorological conditions to visual meteorological conditions, the PF slowed the aircraft from the approach speed of 120 knots to the crew's calculated landing reference speed (V_{REF})[4] of 105 knots, which was also the estimated speed at touchdown.

The aircraft touched down at approximately the midway point of the 4004-foot runway. After touchdown, the PF selected reverse thrust and depressed the brake pedals. At a point approximately 70 feet from the end of the runway, the aircraft had a groundspeed of approximately 40 knots. The aircraft continued along the runway and exited the hard surface.

Touchdown zone and standard operating procedures

Transport Canada defines a touchdown zone (TDZ) as:

> The first 3 000 ft of the runway or the first third of the runway, whichever is less, measured from the threshold in the direction of landing.[5]

When this definition is applied to Runway 06/24 at CYMO, it is intended that flight crews touch down within the first 1335 feet of this 4004-foot runway.

In 2020, the TSB published its investigation report on a runway overrun of a Beechcraft King Air A100 at Havre St-Pierre Airport, Quebec, that occurred on 26 February 2018.[6] In it, the TSB highlighted the U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 91-79A that provided "ways for pilots and airplane operators to identify, understand, and mitigate risks associated with runway

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2 Area navigation (global navigation satellite system)

3 VHF (very high frequency) omnidirectional range

4 V_{REF} refers to the approach speed at a height of 50 feet above the runway in the landing configuration.

5 Transport Canada, TP 14371, *Transport Canada Aeronautical Information Manual* (TC AIM), GEN – General (25 March 2021), section 5.1 Glossary of Aeronautical Terms.

6 TSB Air Transportation Safety Investigation Report A18Q0030.

overruns during the landing phase of flight"[7] through the development of specific standard operating procedures (SOP). The investigation also identified that the Flight Safety Foundation had released several recommendations promoting policies and SOPs to reduce the risk of runway overruns.[8] Some of these recommendations specifically mention issues and threats that were relevant to the 2018 occurrence flight, such as the publication of information and procedures for landing on a contaminated runway and a policy banning landings beyond the TDZ. However, the company involved in that occurrence had not incorporated these recommendations into its operations, nor was there a requirement to do so.

Similarly, Thunder Airlines did not require flight crews to brief the TDZ, procedures to follow if an aircraft flies past this zone, or considerations for contaminated runways.

Hydroplaning

Hydroplaning, also referred to as aquaplaning, occurs when a layer of water builds between the aircraft tires and the runway surface, leading to a loss of traction and preventing the aircraft from responding to control inputs such as steering or braking. According to the FAA, "[l]anding at higher than recommended touchdown speeds exposes the aircraft to a greater potential for hydroplaning. […] Once hydroplaning starts, it can continue well below the minimum initial hydroplaning speed."[9]

According to the *Transport Canada Aeronautical Information Manual*,

> Under these conditions, the tire traction drops to almost negligible values, and in some cases, the wheel will stop rotating entirely. The tires will provide no braking capability and will not contribute to the directional control of the aircraft. The resultant increase in stopping distance is impossible to predict accurately, but it has been estimated to increase as much as 700 percent.[10]

Generally, there are 3 distinct types of hydroplaning, which are described as follows:

Viscous hydroplaning occurs at a relatively low speed on a wet runway. The friction between the tire and runway is reduced, but not to a level that impedes the wheel rotation.

Dynamic hydroplaning occurs at a higher speed. In this condition, the tire is completely raised off the ground by the water layer, thus impeding braking action.

Reverted rubber hydroplaning happens when a locked tire skids along the runway surface. This generates enough heat to change water into steam and to melt (revert) rubber to its original uncured state. Only this type of hydroplaning produces a clear mark on the tire tread in a form of a burn (a spot of reverted rubber) and possibly steam-cleaned marks on the runway when sufficient heat is generated between the tire and the runway to change the water into steam.

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[7] Federal Aviation Administration (FAA), Advisory Circular (AC) 91-79A, *Mitigating the Risks of a Runway Overrun Upon Landing*, Change 2 (revised 20 February 2018).

[8] Flight Safety Foundation, *Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative* (May 2009), pp. 157–160.

[9] Federal Aviation Administration (FAA), FAA-H-8083-25B, *Pilot's Handbook of Aeronautical Knowledge* (2016), Chapter 11: Aircraft Performance, page 11-14.

[10] Transport Canada, TP 14371, *Transport Canada Aeronautical Information Manual* (TC AIM), AIR – Airmanship (25 March 2021), section 1.6.6: Wet Runways.

In this occurrence, while there were no steam-cleaned marks observed on the runway, each of the 4 main landing gear tires on the aircraft exhibited a patch of reverted rubber associated with reverted rubber hydroplaning.

Hydroplaning speed

> The minimum speed at which a non-rotating tire will begin to hydroplane is lower than the speed at which a rotating tire will begin to hydroplane because a build up of water under the non-rotating tire increases the hydroplaning effect. […].[11]

Thunder Airlines maintains the main tire pressure on the Beechcraft King Air A100 within a range of a minimum of 88 psi to a maximum of 110 psi. Post-accident tire pressures were not recorded.

Minimum hydroplaning speed are listed below (**Error! Reference source not found.**).

Table 1. Minimum hydroplaning speeds

Tire pressure (PSI)	Non-rotating tire speed (knots)	Rotating tire speed (knots)
88	72.2	84.4
110	80.7	94.3

TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

Runway overruns have been on the TSB Watchlist since 2010. Despite the millions of successful movements on Canadian runways each year, runway overrun accidents sometimes occur during landings or rejected takeoffs. Between 2005 and 2019, there have been on average 9.7 runway overrun occurrences per year at Canadian airports, of which 7.5 occur during landing. Additionally, in that same time period, the TSB investigated 19 such occurrences and issued 4 recommendations to Canadian authorities. At the time of writing this report, 3 of the recommendations are active[12] and 1 is closed.[13]

A concerted effort is required to reduce such occurrences and includes action required[14] by airports and Transport Canada.

[11] Ibid.

[12] TSB recommendations A07-06, A07-05, and A07-01.

[13] TSB Recommendation A07-03.

[14] Transportation Safety Board of Canada, "TSB Watchlist 2020: Runway overruns", at https://www.bst-tsb.gc.ca/eng/surveillance-watchlist/aviation/2020/air-02.html (last accessed 02 February 2022).

Safety action taken

Thunder Airlines issued a "Long landings and precision approaches" memo to all flight crew on 25 August 2021, reminding them of the following points:

- the importance of flying a stabilized approach to touchdown and within the associated parameters
- the importance of conducting a go-around if the approach becomes unstable
- the importance of speed control and touchdown point
- braking techniques and the risks associated with hydroplaning
- revised approach minima of 300 feet AGL for approaches with vertical guidance to runways less than 4200 feet in length, unless:
    - the runway is bare and dry, or
    - there is a headwind component of 10 knots or greater.
    - CAP minima may be used when either or both of the above conditions are present.

Safety message

It is important that flight crews include in their approach briefings known hazards, such as touching down beyond the TDZ or the potential to hydroplane when landing on a wet runway, and mitigation strategies, such as being prepared to conduct a go-around.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 02 February 2022. It was officially released on 11 February 2022.

ABOUT THIS INVESTIGATION REPORT

This report is the result of an investigation into a class 4 occurrence. For more information, see the Policy on Occurrence Classification at www.tsb.gc.ca

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