Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A10W0171

STALL ON APPROACH/LOSS OF CONTROL

KENN BOREK AIR LTD.
BEECHCRAFT KING AIR 100 C-FAFD
KIRBY LAKE, ALBERTA
25 OCTOBER 2010

Canada

Aviation Investigation Report

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Synopsis

The Kenn Borek Air Ltd. Beechcraft 100 (registration C-FAFD, serial number B-42), operating as KBA103, was on an instrument flight rules flight from the Edmonton City Centre Airport to Kirby Lake, Alberta. At approximately 1114 Mountain Daylight Time, during the approach to Runway 08 at the Kirby Lake Airport, the aircraft struck the ground, 174 feet short of the threshold. The aircraft bounced and came to rest off the edge of the runway. There were 2 flight crew members and 8 passengers on board. The captain sustained fatal injuries. Four occupants, including the co-pilot, sustained serious injuries. The 5 remaining passengers received minor injuries. The aircraft was substantially damaged. A small, post-impact, electrical fire in the cockpit was extinguished by survivors and first responders. The emergency locator transmitter was activated on impact.

Other Factual Information

History of Flight

The occurrence flight (KBA103) originated from the Calgary International Airport on the morning of 25 October 2010 on a regularly scheduled flight to Kirby Lake, Alberta (CRL4). The crew members arrived at the Kenn Borek Air Ltd. hangar at around 0630 [1] to prepare the aircraft for its initial leg to the Edmonton City Centre Airport. KBA103 departed at 0845 with 2 passengers and arrived at the Edmonton City Centre Airport at 0936.

Eight passengers were aboard the Edmonton to Kirby Lake leg. Prior to departure, the flight crew checked the weather conditions at Kirby Lake via a website. It was determined that conditions were not within the applicable limits to attempt the flight. The flight was delayed until 1016 when ceiling and visibility had improved. KBA103 departed Edmonton at 1020.

Approximately 35 nautical miles (nm) from Kirby Lake, the crew began to prepare for the instrument approach to Runway 08 based on area navigation (RNAV) using a global navigation satellite system (GNSS) (see Appendix A). During the descent and approach to Kirby Lake, the crew engaged in a non-essential conversation that was not related to the operation of the aircraft. During this time, KBA103 was cleared out of controlled airspace to conduct an instrument approach.

The first officer was the pilot flying (PF) and flew an autopilot, coupled approach from the right seat. The global positioning system (GPS) track information was only fed into the left side horizontal situation indicator. The PF obtained lateral track information from the panel mounted GPS unit in the centre of the instrument panel. This increased the instrument scan workload for the PF.

The flight proceeded towards the ROPRO waypoint from the south with the intent of continuing to the DEDEK waypoint. During the descent, the crew began to encounter light to moderate icing conditions and elected to fly directly to the XIKIB waypoint on a track of 078°Magnetic (M), bypassing the DEDEK waypoint and continuing the descent to 3500 feet above sea level (asl). The approach profile was conducted at 140 knots indicated airspeed (KIAS) due to icing conditions. Anti-icing equipment was active and the de-icing boots were activated 6 times during the approach. Having deviated from the approach profile, the minimum sector altitude of 3800 feet asl would have been applicable. The flaps were set at the approach setting (12.9°) and the crew confirmed that the RNAV 08 approach was loaded into the GPS unit and a receiver autonomous integrity monitoring (RAIM) check was performed. The landing gear was extended and the propellers were advanced to the fine pitch setting.

As KBA103 approached the AXAXA final approach waypoint, the captain, who was the pilot not flying (PNF), indicated that he would be looking outside in order to locate the aerodrome. The AXAXA waypoint was located 4.9 nm from the threshold of Runway 08. After crossing the AXAXA waypoint, the next applicable altitude to which KBA103 could descend was the minimum descent altitude (MDA) of 2760 feet asl. The crew had agreed to round off the MDA to 2700 feet asl. Neither crew member made the required calls of 100 feet prior to 2700 feet asl or

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1 All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

passing through and descending below 2700 feet asl. [2] At approximately 4 nm from the threshold of Runway 08, the runway was visually identified by the PNF. However, the PF was not able to identify the runway. Throughout the remainder of the approach, both pilots were predominantly looking outside of the aircraft. The course deviation indicator on the GPS indicated that KBA103 was slightly right of track. The PF disconnected the autopilot and proceeded to re-intercept the inbound track, flying the aircraft by hand. At approximately 3 nm from the runway, the PNF identified the road that led to the airport, indicating that the runway was to the left of the road. At about 1 mile final, the PNF pointed out the radio tower to the right of the runway (located mid field); however, the PF did not have the runway in sight. Shortly thereafter, the PF identified the runway. Approximately 14 seconds later, the aircraft's left wing dropped and the crew lost control of the aircraft. There was no audible warning to the approach of a stall. Maximum power was required, but recovery was not achieved prior to the aircraft hitting the ground.

Instrument Approach Procedures

A GPS approach provides lateral information to the pilots regarding the waypoints towards which they are to fly. After each waypoint, the pilot is allowed to descend to the next minimum altitude for that leg. Ultimately, the pilot will cross the final approach waypoint, in this case AXAXA, and descend to the MDA of 2760 feet asl (500 feet above ground level [agl]). The pilot is to remain at this altitude until visual reference (see Figure **1**) of the runway environment is acquired [3], at which time, a visual descent may be made for landing. Only 1 of these references is required.

Canada Air Pilot – Gen (Landing Minima)
Visual References

a) Runway or runway markings;
b) Runway threshold or threshold markings;
c) Touchdown zone or touchdown zone markings;
d) Approach lights;
e) Approach slope indicator system;
f) Runway identification lights;
g) Threshold and runway end lights;
h) Touchdown zone lights;
i) Parallel runway edge lights; or
j) Runway centreline lights.

Figure 1. Visual references for landing

The outside surface temperature was -3°C. A cold temperature correction was not applied to the altitudes on this approach; if it had been, the MDA would have been corrected to 2796 feet asl (536 feet agl). [4]

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2 Kenn Borek Air Ltd. standard operating procedures for non-precision approaches require altitude calls 100 feet above MDA and at MDA.

3 Kenn Borek Air Ltd. standard operating procedures imply that MDA is to be maintained until the missed approach point, which would be the last point were the PNF would be able to call runway in sight. The PF would confirm contact and state that they would be landing or, if no contact, initiate a missed approach.

4 Transport Canada, *Aeronautical Information Manual* (TP 14371E), RAC 9.17.1, Corrections for Temperature.

Sterile Cockpit Procedures

The concept of a sterile cockpit has been in practice for a number of years. Although the *Canadian Aviation Regulations* do not require the implementation of a sterile cockpit, various air operators have included this concept in their daily operations, standard operating procedures (SOP) or company operation manual (COM). The U.S. Federal Aviation Administration has implemented a Federal Aviation Regulation (FAR 135.100) stating, in part, that:

> (b) No flight crew member may engage in, nor may any pilot in command permit, any activity during a critical phase of flight which could distract any flight crew member from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in non essential conversations within the cockpit…
>
> (c) For the purposes of this section, critical phases of flight includes all ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet, except cruise flight.

The Kenn Borek SOP states that there should be no conversation other than that required for assigned work or for the operation of the aircraft during the descent from 3000 feet agl or top of descent, which ever occurs last.

Accident Site

The aircraft touched down in a level, grass and scrub-covered field, 174 feet short of the runway. The field ended with a 17 foot uphill slope to the runway threshold. The left wing made initial contact and the fuselage impacted the ground in a tail-low attitude.. The aircraft came to rest on the left edge of the runway, facing the opposite direction. The total length of the wreckage trail was 439 feet.

Based on damage to the propellers, the investigation determined that the engines were producing high power. Propeller blade marks on the ground indicated that the aircraft impacted the terrain at an approximate ground speed of 108 knots. Damage to the aircraft suggests that it experienced a low-energy impact.

The left wing and cockpit were substantially damaged. The cabin remained intact, although 3 seats broke free. After the aircraft came to rest, 2 passengers were able to evacuate via the emergency exit on the right-hand side. The remaining passengers evacuated through the main cabin door on the left side. The first officer was able to extract himself from his seat and was assisted from the aircraft by the passengers. The captain remained in the left seat until emergency medical services personnel were able to extract him from the aircraft. Local personnel on the airport apron initiated an emergency response; emergency medical services personnel treated the injured occupants until they were transported to medical facilities. A small, post-impact, electrical fire ignited in the front, left-hand side of the cockpit area. Passengers and first responders used hand-held fire extinguishers to put it out. The ELT was activated as a result of impact forces and was detected by the Joint Rescue Coordination Centre Trenton at 1114.

Weather

Weather conditions at the time of the occurrence were instrument meteorological conditions. KBA103 was delayed in departure from the Edmonton City Centre Airport, pending an improvement in ceiling and visibility at Kirby Lake. Prior to departure, the crew was able to check the weather conditions at Kirby Lake via a website that recorded weather observations at the airport. The automated weather observation system was available at Kirby Lake, and the crew was able to access it enroute via onboard radio. Weather conditions near the time of the occurrence (1110) were as follows: wind 170° True (T) at 8 knots gusting to 16 knots, visibility 4 statute miles (sm) in light snow, overcast ceiling at 600 feet agl, temperature of -3°C, dew point of -4°C and altimeter setting 29.50 inches of mercury.

During the approach to Kirby Lake, KBA103 encountered moderate, mixed icing. The post impact inspection of the aircraft indicated that the leading edges of the wings and horizontal stabilizer were clear of ice contamination. C-FAFD was certified for flight into known icing and was equipped with de-icing equipment, which included windshield heat, engine intake heat, engine anti-ice vanes, pitot heat, propeller de-ice and wing de-icing boots. All of these systems were functional and used during the approach.

Transport Canada – *Aeronautical Information Manual* - 2.12.3.2 Aerodynamic Effects of Airborne Icing

Commercial pilots are familiar with the classic aerodynamic effects of ice accumulation on an aeroplane in flight. These can include:

(a) reduced lift accompanied by significant increases in drag and increases in weight;
(b) increases in stall speed and reduced stall angle of attack as ice alters the shape of an airfoil and disrupts airflow.

Flight Crew

The captain held a valid Canadian airline transport pilot's licence (aeroplane) at the time of the occurrence. He had been employed with Kenn Borek Air Ltd. since 2003 and had received company training in crew resource management and avoiding controlled flight into terrain within the previous 12 months. The captain occupied the left-hand seat in the cockpit and was acting as PNF. Although responsible for the aircraft at all times, he was not operating the flight controls during the flight from Edmonton to Kirby Lake.

The first officer held a valid Canadian commercial pilot's licence (aeroplane) at the time of the occurrence. He had been employed with Kenn Borek Air Ltd. since 2007 and had received company training in crew resource management and avoiding controlled flight into terrain within the previous 12 months. The co-pilot occupied the right-hand seat in the cockpit and was acting as PF.

Company Standard Operating Procedures

The aircraft is equipped with a set of flight instruments for each pilot. According to company SOP, during an instrument approach, the PF is to use the aircraft's instruments to maintain physical control of the aircraft. The PNF is responsible to monitor the instruments on their side of the aircraft and, to announce when the aircraft is 100 feet above the next authorized altitude and when it arrives at that altitude. Additionally, the PNF is to inform the PF of any deviations in altitude, heading or airspeed. The PNF is also responsible for the visual identification of the

runway in the final stages of the approach. Once obtained, the PNF must inform the PF, who then visually confirms that the runway was identified and indicates that the approach will proceed with a landing.

The current weight and balance report (amendment number 18) had been issued effective 13 September 2010. The aircraft had been dispatched using the previous weight and balance report (amendment number 17) because the flight planning software had not been updated to reflect the change. Additionally, the weight for the crew and passengers was determined using company standard weights, [5] as opposed to their actual weights. Kenn Borek Air Ltd. had issued a memo to flight crews that actual weights were to be used for weight and balance calculations when flying for this particular client. While the aircraft was within its certified weight and balance limitations, the aircraft was approximately 325 pounds heavier than that indicated on the operational flight plan.

Maintenance

The aircraft had been maintained in accordance with existing regulations and there were no outstanding defects.

Recorders

The aircraft was equipped with a Fairchild A100 cockpit voice recorder (CVR). The CVR was recovered at the scene and transported to the TSB Laboratory for analysis.

Stall Warning System

The aircraft was equipped with a stall warning system designed to aurally alert the flight crew if the aircraft speed reaches 5 to 8 knots above the stall speed when the wings are free of ice. The stall speed calculated for the aircraft at 10 900 pounds [6] was between 63 knots calibrated airspeed (KCAS) and 85 KCAS [7].

The aircraft was equipped with a lift tranducer vane and face plate on the left wing. Aerodynamic pressure on the vane indicates that a stall is imminent. The transducer vane is protected from ice by a heater. A build up of ice on the wing, however, may disrupt the airflow over the vane and prevent the system from accurately indicating an imminent stall. Damage to the left wing precluded the inspection of the stall warning and anti-ice systems.

Additionally, the aircraft was equipped with a safe flight system, which was coupled to the stall warning vane. This system assesses angle of attack information from the lift transducer and provides the crew with a visual indication as to whether the airspeed is above or below the best approach speed. As it was tied to the stall warning horn, it did not provide any additional information to the crew. It was also reported that crews rarely referred to this system.

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5 Company Standard Weights - Summer: Males – 187 pounds; Females – 152 pounds.

6 The weight of 10 900 pounds was determined during the investigation using actual crew, passenger and cargo weights.

7 Stall speeds were determined as follows: 63 KCAS – power on, flaps at the approach setting and landing gear extended; 85 KCAS – power off, flaps at the approach setting and landing gear extended.

Low speed warning/alerting systems have been used within the aviation industry and rely on indicators that function independently of the traditional stall warning systems. A National Transportation Safety Board Safety Recommendation [8] identifies the usefulness of a low airspeed alerting system:

> The Safety Board (NTSB) recognizes that the development and requirement of a low-airspeed alert system is a departure from the previously accepted premise that adequate low-airspeed awareness is provided by flight crew vigilance and existing stall warnings. However, … the history of accidents involving flight crew lack of low-airspeed awareness suggest that flight crew vigilance and existing stall warnings are inadequate to reliably prevent hazardous low-airspeed situations and that this unsafe condition is not unique to autopilot operations or flight in icing conditions. If a low-airspeed alert system had been installed on the accident airplane, it might have directed the attention of the accident flight crew to the airplane's decaying airspeed in time for them to initiate appropriate corrective action.

The following TSB laboratory reports were completed:

LP 152/2010 – CVR Download & Transcript
LP 161/2010 - Annunciator Lamp Analysis

These reports are available from the Transportation Safety Board of Canada upon request.

Analysis

The analysis will focus on crew performance inside the cockpit, while engaged in non-operational conversation and outside of the cockpit, in particular with regards to both pilots' attention being on obtaining visual reference to the runway at the expense of monitoring the aircraft.

During the initial stages of the approach to Kirby Lake, the crew was engaged in a conversation that did not directly pertain to the operation of the flight. The casual nature of the conversation between the PF and PNF suggests that they were not overly concerned with the approach and may not have been at a heightened level of attention. While a majority of the SOP and checklist items were completed during the approach, a number of critical items, such as descending below the minimum sector altitude while diverting to the XIKIB waypoint and failing to announce/confirm the arrival at the MDA, were indicative of lapses in cockpit discipline.

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8 National Transportation Safety Board Safety Recommendations A-03-51 through -54. 02 December 2003.

Beyond the distraction within the cockpit, the crew was faced with the additional task of identifying the runway. Although the company SOP did not specify when the PNF sould look outside, the automated weather observation system at Kirby Lake indicated that the visibility was 4 sm in light snow. This likely prompted the PNF to look outside of the cockpit at a GPS distance of 4 nm and to identify the runway. This declaration prompted the PF to look up from monitoring the flight instruments in an attempt to identify the runway. For the remainder of the flight, both crew members were focused outside the cockpit. With neither pilot monitoring the airspeed and altitude, the aircraft continued to descend. From the initial identification of the runway, the airspeed decreased to a point that it entered an aerodynamic stall. The aircraft was, however, too low to effect a recovery, despite attempts by the crew to do so.

The loss of control of the aircraft was likely the result of a stall or near stall condition. The ground speed determined by the propeller marks and the high engine power setting during the attempted recovery indicate that the aircraft was in a low energy state. The aircraft's close proximity to the ground prevented a full recovery from the loss of control.

Pilots are often expected to perform a number of concurrent activities. In this case, this involved flying and monitoring the aircraft as well as visually acquiring the runway. During these multi-tasking situations, the crew may prioritize activities based on their perceived level of importance. In this case, the act of visually finding the runway was categorized as being of primary importance. As such, the crew’s cognitive efforts were directed to this activity at the expense of monitoring the aircraft’s flight profile.

The aircraft was equipped with a stall warning system, which did not activate prior to the aircraft entering a low energy state.The aircraft’s wing de-icing system appeared to be functional throughout the approach and the post impact inspection of the aircraft did not indicate an accumulation of ice on the critical flight surfaces. The investigation was unable to determine why the stall warning system did not activate.

Findings as to Causes and Contributing Factors

1. The conduct of the flight crew members during the instrument approach prevented them from effectively monitoring the performance of the aircraft.

2. During the descent below the minimum descent altitude, the airspeed reduced to a point where the aircraft experienced an aerodynamic stall and loss of control. There was insufficient altitude to effect recovery prior to ground impact.

3. For unknown reasons, the stall warning horn did not activate; this may have provided the crew with an opportunity to avoid the impending stall.

Findings as to Risk

1. The use of company standard weights and a non-current aircraft weight and balance report resulted in the flight departing at an inaccurate weight. This could result in a performance regime that may not be anticipated by the pilot.

2. Flying an instrument approach using a navigational display that is outside the normal scan of the pilot increases the workload during a critical phase of flight.

3. Flying an abbreviated approach profile without applying the proper transition altitudes increases the risk of controlled flight into obstacles or terrain.

4. Not applying cold temperature correction values to the approach altitudes decreases the built-in obstacle clearance parameters of an instrument approach.

Safety Action Taken

Kenn Borek Air Ltd. has taken the following safety actions:

- Amended the weight and balance calculation procedure to require flight crews to confirm the correct aircraft configuration and passenger weights.

- Implemented a company line check program to include *Canadian Aviation Regulations* 703 and 704 operations to ensure adherence to standard operating procedures (SOP), including sterile cockpit procedures.

- Developed and implemented a procedures review exam for fight crew, emphasizing SOP and company procedures for stabilized approaches, sterile cockpit, and crew roles and duties during non precision approaches at remote airports with limited services.

- Amended company SOP and placarded aircraft equipped with a Garmin 155XL regarding conducting GPS approaches. These approaches will be flown from the left seat only.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 June 2010.

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 - Restricted Canada Air Pilot – Kirby Lake RNAV (GNSS) RWY 08

NOT TO BE USED FOR NAVIGATIONAL PURPOSES