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

AVIATION INVESTIGATION REPORT
A05C0222

RUNWAY EXCURSION

AIR CANADA
AIRBUS A319-112 C-GJTC
WINNIPEG INTERNATIONAL AIRPORT, MANITOBA
26 DECEMBER 2005

Canada

Aviation Investigation Report

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Summary

The Air Canada Airbus A319-112 (registration C-GJTC, serial number 1668), operating as ACA261, was landing at Winnipeg International Airport, in darkness, at 1835 central standard time. An instrument landing system approach to Runway 13 was flown using the autopilot. At approximately 80 feet above ground level, the captain disengaged the autopilot and manually completed the approach and landing.

The aircraft touched down firmly approximately 1600 feet from the runway threshold and well left of the runway centreline. During the rollout, the left landing gear tracked briefly outside of the runway edge lights on the left side of the runway. Two of the runway edge lights were broken. One tire of the left wheel set sustained a cut and was replaced. There was no other damage to the aircraft, and there were no physical injuries.

Ce rapport est également disponible en français.

Other Factual Information

Weather

The most recent weather observation at Winnipeg was the 1815 central standard time[1] observation and was as follows: wind 180° true (T) at 8 knots gusting to 15 knots; vertical visibility 100 feet; visibility ⅜ statute mile (sm); runway visual range (RVR) for Runway 13 in the 10 minutes before the observed weather was variable with 3500 feet minimum and 6000 feet maximum; temperature and dew point –1°C; precipitation freezing fog; fog eight oktas.[2]

The automatic terminal information service (ATIS) weather available to the crew was based on the weather at 1805 and was as follows: wind 170° magnetic (M) at 12 knots, vertical visibility 200 feet; visibility ½ sm; temperature and dew point –1°C; precipitation freezing fog; altimeter 25.51 inches. At four miles on final approach, the crew members were given an advisory that the RVR was 2600 feet. An approach was authorized under the prevailing visibility.

A crew that had landed about three minutes after ACA261 indicated that the weather was essentially as reported by the ATIS and that the runway end and edge lights provided sufficient reference for a landing at minimums. The sequenced lights along the approach path were visible on approach but disappeared temporarily as the aircraft descended through a fog layer, from 500 to 400 feet above ground level (agl). To avoid reflection from the freezing fog particles, the crew of this aircraft did not use landing lights.

Runway

The runway surface condition report for Runway 13 issued at 1221 indicated that a strip about 100 feet wide down the runway centreline was 50 per cent bare and dry, 50 per cent bare and wet. The remainder of the runway on the sides was reported as 30 per cent bare and dry with 30 per cent ice patches.

Runway 13 was served by a precision approach Category I instrument landing system (ILS) with a decision height of 200 feet agl. The approach plate advisory visibility was ½ mile or 2600 feet. The final approach course was 134°M with a standard 3° glide slope. As specified in the *Canada Air Pilot* (CAP), once at the decision height, the captain may continue for landing provided that the required visual references are established.

The lighting for Runway 13 is considered appropriate for Category I approaches. The approach lighting is 2400 feet long. The system is high intensity, with runway alignment indicator lights. There are five sequenced flashing lights in the first 1000 feet (in the direction of landing) followed by 1400 feet of white runway alignment indicator lights. The beginning of the runway in the direction of landing is marked by green threshold lights. The white runway edge lights

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[1] All times are central standard time (Coordinated Universal Time minus six hours).

[2] The opacity of cloud layers is measured in eighths of the sky concealed (oktas).

are spaced at 200-foot intervals for the full length of the runway and were set at full intensity, level 5, at the time of the incident. The edge lights are light weight and frangible. The lights are positioned about five feet outside of the runway edge, in asphalt strips. The asphalt strips, which extend seven feet on each side of the runway and along its entire length, facilitate snow clearing around the edge lights (Figure 1).

Captain

The captain had been employed with Air Canada and previously with Canadian Airline International Ltd. for about 22 years and had approximately 15 000 hours of total flying time with approximately 2500 hours on the Airbus. His training records indicate excellent crew resource management skills. He was rested and had completed two 8-hour duty days in the 48 hours before the occurrence flight.

The captain held a valid airline transport pilot licence subject to the limitation that he wear glasses. Contact lenses were approved. He was wearing both contact lenses and glasses, which in combination met his vision prescription. The lenses were progressive lenses with no distinct line between the distance and reading segments. The glasses were new, and the captain had worn them only a few times while flying. For some individuals, progressive lenses have a longer adjustment period than segmented lenses. The captain had never before worn his new glasses while landing in low visibility.

Following the occurrence, the captain obtained bifocal glasses with a clear demarcation between the distance and reading segments. Reportedly, there was a significant difference between the two types of lenses: the progressive lenses caused distortion in peripheral vision with small head movements; the segmented lenses did not.

First Officer

The first officer held a valid airline transport pilot licence with the requirement that he wear glasses, which he did on the incident flight. He had been employed with the company for about six years and had approximately 9700 hours of total flying time, including approximately 2400 hours on the Airbus. The first officer had requalified on the Airbus in May 2005 after 18 months on the Bombardier RJ. His training record noted excellent crew resource management skills. In the two days immediately preceding the incident flight, he had flown 10 hours, and he had been off duty for the three days before the duty.

Approach and Landing

Before the approach, the crew briefed and discussed a possible missed approach. Because of the low visibility and ceiling, the crew decided that the captain would fly the approach and landing. The navigation system was programmed for the possible missed approach, and the cabin crew was advised of the weather conditions in Winnipeg and the possibility of executing a missed approach.

A Category I ILS approach to Runway 13 was flown on autopilot. The approach was flown in accordance with existing *Canadian Aviation Regulations* and company standard operating procedures. The captain was the pilot flying (PF) and flew from the left seat. The autopilot was engaged and was coupled to the ILS. The auto-thrust system was also active, and the automatic systems flew a stabilized approach profile at a speed of approximately 130 knots. The first officer, the pilot not flying (PNF), monitored the approach on instruments. The approach lights were visible to both pilots about 100 feet above decision height (DH), and the PF elected to land. Neither pilot could see the runway surface at DH. The aircraft landing lights were on during the approach and landing. The PF disengaged the autopilot at about 80 feet agl and continued flying the approach manually.

When the captain disengaged the autopilot, it was believed that the aircraft was over the extended runway centreline with the wind drift eliminated. However, the runway surface was obscured by fog and the reflection from the landing lights. Approximately three seconds after the autopilot was disengaged, the PF banked left about four to five degrees. At about 30 feet agl, the PNF looked up and observed the aircraft drifting to the left and advised the PF, who was not taking action to stop the drifting. The call was acknowledged. The PF began the landing flare, slightly reduced the left bank, and moved the thrust levers to idle. Immediately before touchdown, the PF made a large right rudder input, and the aircraft landed hard, while crabbed to the right. There was some vibration during the initial part of the rollout as the PF steered the aircraft toward the runway centreline and braked.

The PF inspected the aircraft with maintenance personnel at the gate while the passengers deplaned. No damage was found. Subsequent inspection by maintenance personnel revealed a cut in one of the left main wheel tires.

A runway inspection was conducted by airport staff immediately after the occurrence. Skid marks from the aircraft's right main gear tires were found on the runway. Two broken runway edge lights were found in the path of the aircraft's left landing gear (see Figure 1).

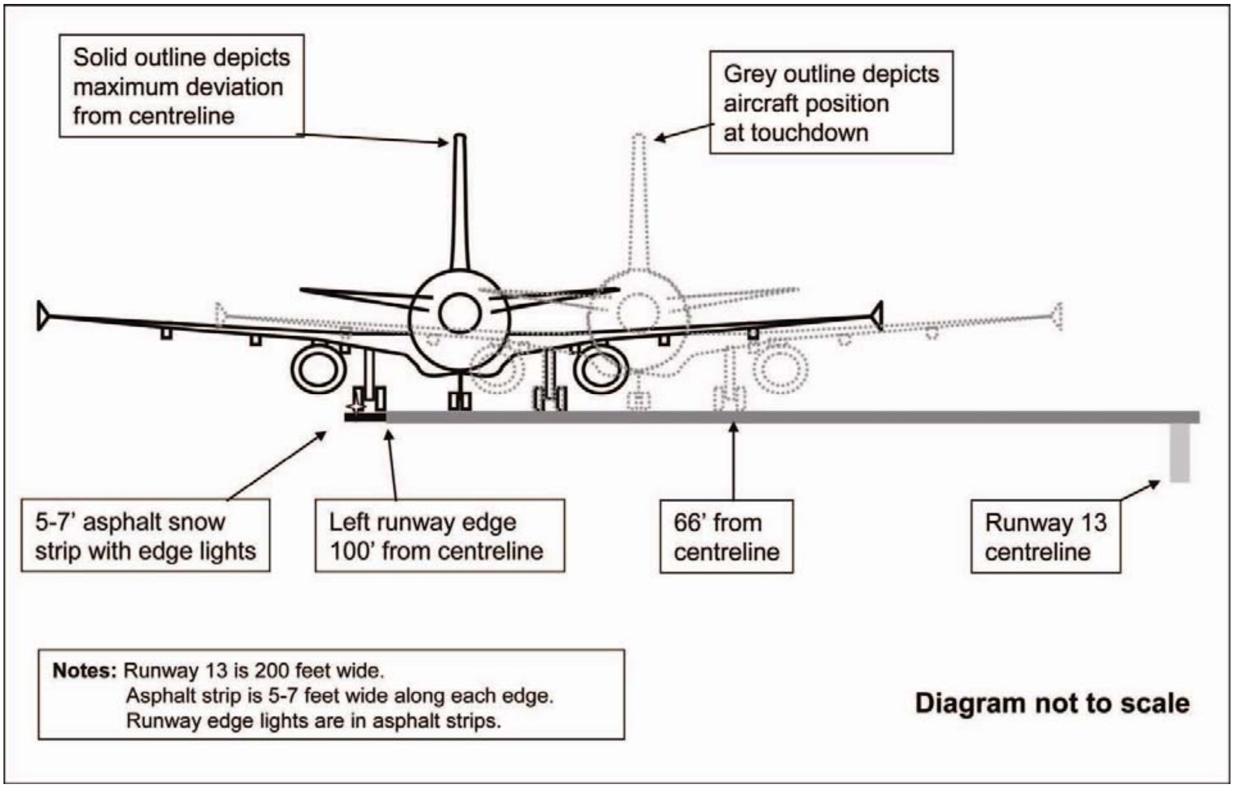

Figure 1. View in direction of landing

Investigators found skid marks on the runway indicating that the right main landing gear was about 66 feet left of the runway centreline at touchdown and that the aircraft was skidding to the left. Tracks made by the left wheel on snow and ice were no longer visible. Since the left and right main gear are approximately 25 feet apart, it was determined that the left main gear was approximately 91 feet from the runway centreline, 9 feet from the edge of the runway at touchdown.

The skid marks of the right main gear tires continued towards the left edge of the runway for about 350 feet and then tracked back towards the centreline for another 350 feet. The furthest point of the right main gear tires skid mark from the centreline was approximately 83 feet. The left main gear of the aircraft struck two runway edge lights. Approximately 350 feet from the touchdown point, the left main gear was about 108 feet from the centreline, 8 feet outside the runway, on the left asphalt snow strip (see figures 1 and 2).

Airport Surface Detection Equipment

Radar surveillance of airport surface traffic is provided at Winnipeg by airport surface detection equipment (ASDE). This system is high-definition primary surveillance radar and is used by controllers to monitor the position of aircraft and vehicles on the manoeuvring areas of the airport, particularly during reduced visibility conditions. The ground controller observed the landing of ACA261 on the ASDE and saw the aircraft track near the edge lights on the left side of the runway.

The radar tape showed the aircraft crossing the runway threshold near the runway centreline. The aircraft then drifted left of the centreline, with the radar track corresponding to the wheel skid marks found on the runway. The ASDE also revealed that, as ACA261 was landing, a vehicle was holding on Taxiway Kilo, at the hold line for Runway 13 (see Figure 2).

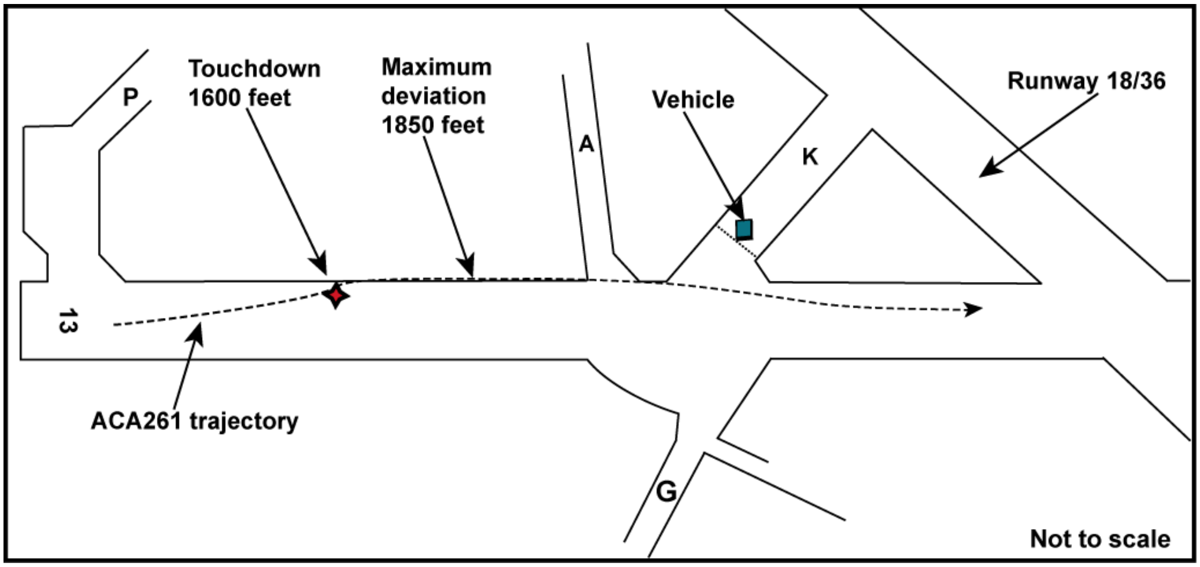

Figure 2. Overhead view of Runway 13 and ACA261 trajectory

Approach Radar Information

The approach of ACA261 was recorded on radar files in the area control centre. Playback of the digital radar file indicated that a stable ILS approach had been flown to Runway 13. The recorded approach was similar to an approach flown by a Boeing 737 about three minutes later.

Damage to the Aircraft

Maintenance inspection found a cut in one tire from the left main wheel set. The tire was replaced; the aircraft was then dispatched shortly after the incident.

Flight Recorders

The aircraft was equipped with a Honeywell, two-hour cockpit voice recorder (CVR), serial number 309. The Air Canada Flight Operations Manual requires that the CVR circuit breaker be pulled after gate arrival on any flight leg during which an incident/accident has occurred.[3] The crew did not pull the circuit breaker after the occurrence, and Air Canada Flight Operations did not ensure that the CVR had been secured. Since there was no damage to the aircraft and it was dispatched shortly after the incident, the voice recording of the incident was overwritten. Consequently, CVR information relevant to the occurrence was not available to TSB investigators.

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[3] Air Canada Flight Operations Manual, Section 6.3, page 13, dated 01 March 2003

The aircraft was equipped with a digital flight data recorder (FDR), which was removed from the aircraft after completion of the following flight, and the data were downloaded for analysis. The data were also used in conjunction with other information to produce a computer-generated video of the incident. The video and the FDR tabular data were used to review the flight profile during the approach and landing. The FDR information and analyses indicated that, about three seconds after the autopilot was disengaged and shortly after the approach and runway end lights disappeared under the nose of the aircraft, a left bank of about four to five degrees was commanded by the captain's side stick controller. It was approximately two seconds later that the PNF called out that the aircraft was drifting.

The application of rudder to stop the drift occurred about three seconds later, as the thrust levers were moved to idle. The left bank was reduced, but a small amount of bank remained until the aircraft touched down, approximately five seconds later. The PF made a large right rudder input just before touchdown. The total time from autopilot disengagement to touchdown was approximately 13 seconds.

Visual Illusions

The Flight Safety Foundation (FSF) Approach-and-Landing Accident Reduction (ALAR) Task Force briefing note states that "Visual illusions result from the absence of visual references or the alteration of visual references, which modify the pilot's perception of his or her position (in terms of height, distance and/or intercept angle) relative to the runway threshold." The briefing note also states that, based on statistical data, "Visual approaches at night typically present a greater risk because of fewer visual references, and because of visual illusions and spatial disorientation." The briefing note indicates that, "In crosswind conditions, the runway lights and environment will appear at an angle to the aircraft heading; the flight crew should maintain the drift correction and resist the tendency to align the aircraft with the runway centreline." The briefing note lists crosswind as a factor that causes visual illusions and results in incorrect pilot actions.[4]

Night Vision

The eye can adapt to a wide range of illumination. At night, the best vision is attained by looking 15 to 20 degrees off centre (peripheral vision) so as to utilize the part of the retina sensitive to low levels of light and best suited to detect motion.[5]

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4 FSF ALAR Tool Kit Briefing Note 5.3, Visual Illusions, dated August–November 2000.

5 *Vision in Military Aviation* by Colonel Thomas J. Tredici, United States Air Force (USAF), MC(Ret), Aerospace Ophthalmology Branch, USAF School of Aerospace Medicine; Brooks Air Force Base, Texas.

Corrective Eyewear

An FSF Human Factors and Aviation Medicine article discusses the benefits and risks associated with flight crew members wearing contact lenses. In this article, one of the unique risks identified is that "Contact lenses may increase the eyes' sensitivity to light and glare (such as the glare of runway lights during a night approach to landing)."[6] This article also points out an advantage to contact lenses in that they reduce the distortion that can be present with eyeglasses, since eyeglasses are designed for optimal vision when the wearer looks through the centre of the lens. With eyeglasses, when the wearer looks through some part of the lens other than the centre, distortions in side and peripheral vision can occur. Progressive lenses, in particular, can lead to an apparent widening and distortion of the visual picture at the periphery toward the bottom of the visual field.

Crosswind Landings

An FSF ALAR briefing note on crosswind landings lists factors often involved in crosswind landing occurrences.[7] One of the factors listed is "Insufficient time to observe, evaluate and control aircraft attitude and flight path in a highly dynamic situation."

Other Occurrences

The TSB has investigated a number of occurrences in which inadequate visual references, during the final stage of an approach, contributed to an accident.[8] The referenced occurrences have some commonalities. All involved Category I ILS approaches were conducted during darkness in degraded visibility; at DH, the crews had the required visual reference to continue the approach, but subsequently had difficulty acquiring sufficient visual references to maintain aircraft alignment with the runway.

Analysis

The crew's planning before the approach indicated that they were not fixated on landing at Winnipeg and were prepared to execute a missed approach. They had left themselves options and appeared prepared to execute them. Although the absence of a CVR recording prevented a review of the crew's interaction, the decisions were taken mutually and indicated that crew resource management techniques were used. Their planning also indicated a heightened awareness of the degraded visual environment on the runway. The reported weather and other weather information obtained indicated that the required visual references were available for the landing and that the decision to continue at DH was reasonable.

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6 FSF article entitled "Contact Lenses Present Flight Crewmembers with Benefits, Unique Risks," William A. Monaco, O.D. Ph.D., Vol. 47, No. 2, March–April 2000.

7 FSF ALAR Tool Kit Briefing Note 8.7, Crosswind Landings, dated August-November 2000.

8 TSB reports A05W0010, A04W0032, A97H0011, and A93W0037.

Information also indicated that the aircraft was properly positioned with drift eliminated at DH. The captain's decision was consistent with company operating procedures, and a normal landing in the vicinity of the runway centreline should have been assured, given the captain's training and experience.

Analysis of the FDR information and flight simulation indicated that the aircraft began to drift left because the captain banked the aircraft four to five degrees to the left, removing the crosswind correction. The left bank, coupled with the crosswind from the right, moved the aircraft well left of the runway centreline. The computer flight simulation indicated that the left bank began after the runway approach and threshold lights disappeared under the nose of the aircraft. At this point, only the two rows of runway edge lights were visible and appeared at an angle to the aircraft heading. In this situation, the FSF ALAR briefing note indicates that there is a tendency for pilots to align the aircraft with the runway, which is likely what the PF did. The subsequent drift should have been observed and corrected.

Once visual references were acquired by the PF and the autopilot was disconnected in preparation for landing, the first officer, as PNF responsible for monitoring the approach predominately inside the cockpit, looked up and saw that the aircraft was drifting. The captain, with PF responsibilities predominately outside of the cockpit, did not recognize that the aircraft was moving to the left. While the visual environment was degraded in darkness, and the reflection from freezing fog particles obscured the runway threshold, the external visual environment was essentially the same for both pilots. Even though the PF had to concentrate on controlling the aircraft, the PF rather than the PNF should have been more likely to detect the left drift. Consequently, other factors may have degraded the PF's visual environment.

Another factor influencing the PF's visual environment was the combination of contact lenses and new eyeglasses. First, the effect of the reflection from the freezing fog could have been greater for the PF than for the PNF. Second, the PF may have had some distortion and loss of night vision capability that had not been experienced previously due to the characteristic of progressive eyeglass lenses to interfere with peripheral vision. Third, progressive lenses can require some period of adjustment to use effectively in moving from far to near vision. The PF had worn the eyeglasses only a few times and may not have been fully adjusted to them. Finally, the PF may not have adjusted to the need to look through the centre of the eyeglass lenses, an adjustment that is not necessary with contact lenses, which move with the eye.

As noted in the FSF ALAR briefing note on crosswind landings, time is a critical factor in crosswind landings. The time from autopilot disengagement at 80 feet agl to touchdown was 13 seconds. In the dynamic situation of a landing at night, in degraded visibility, and with a crosswind, the PF had only a few seconds after the call by the PNF to recognize and evaluate the drift and make the appropriate control inputs. The PF reacted within three seconds but did not completely stop the drift before touchdown.

In conclusion, it is most likely that one or more of the effects of the vision correction used by the PF adversely affected his ability to consistently use the required visual references effectively in the rapidly changing, high workload environment of a night landing in low visibility with a crosswind.

The following TSB Engineering Laboratory report was completed:

LP 138/2005—FDR Analysis

This report is available from the Transportation Safety Board of Canada upon request.

Findings as to Causes and Contributing Factors

1. The captain aligned the aircraft with the runway without compensating for crosswind, allowing the aircraft to drift off centreline. After touchdown, the aircraft's left landing gear tracked off the runway.

2. It is likely that one or more of the effects of the vision correction used by the pilot flying interfered with his ability to effectively use the visual references available to land.

Other Finding

1. The cockpit voice recorder (CVR) was not disabled following the occurrence and the data were overwritten. Consequently, CVR information relevant to the occurrence was not available to TSB investigators.

Safety Action

Following the incident, Air Canada issued a flight operations bulletin stating that "The use of auto land should be considered for all approaches in marginal conditions."[9]

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 November 2006.

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9 Air Canada Flight Operations Bulletin 149–05, dated 28 December 2005.