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

AVIATION INVESTIGATION REPORT A17O0025

Runway excursion

Air Canada
Airbus Industrie A320-211, C-FDRP
Toronto/Lester B. Pearson International Airport, Ontario
25 February 2017

Canada

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@tsb.gc.ca

Aviation investigation report A17O0025

Cat. No. TU3-5/17-0025E-PDF
ISBN 978-0-660-26297-0

This report is available on the website of the
Transportation Safety Board of Canada at www.tsb.gc.ca

Le présent rapport est également disponible en français.

Aviation Investigation Report A17O0025

Runway excursion
Air Canada
Airbus Industrie A320-211, C-FDRP
Toronto/Lester B. Pearson International Airport, Ontario
25 February 2017

Summary

On 25 February 2017, an Air Canada Airbus Industrie A320-211 (registration C-FDRP, serial number 122), operating as flight AC623, was on a scheduled flight from Halifax/Stanfield International Airport, Nova Scotia, to Toronto/Lester B. Pearson International Airport, Ontario.

During the approach to Runway 15R, just prior to touchdown, the aircraft began to deviate to the right of the centreline. At 0002 Eastern Standard Time, shortly after touching down near the right edge of the runway surface, the aircraft deviated further to the right and entered the grassy area to the west of the runway. It travelled approximately 2390 feet through the grass and parallel to the runway before returning to the pavement. During the excursion, the aircraft struck 5 runway edge lights, causing minor damage to the left outboard wheel and the left engine cowling. There were no reported injuries. The event occurred during the hours of darkness.

Le présent rapport est également disponible en français.

Factual information

History of the flight

An Air Canada Airbus Industrie (Airbus) A320-211 (registration C-FDRP, serial number 122) airplane, operating as flight 623, was on a scheduled flight from Halifax/Stanfield International Airport (CYHZ), Nova Scotia, to Toronto/Lester B. Pearson International Airport (CYYZ), Ontario, with 2 flight crew members, 4 cabin crew members, and 119 passengers on board.

The flight was scheduled to depart from CYHZ at 2045[1] on 24 February 2017 and to arrive at CYYZ at 2236. However, due to ground delays at the destination airport, the flight did not depart CYHZ until 2244—approximately 2 hours later than scheduled.

The captain, who occupied the left seat, was the pilot flying (PF), and the first officer, who occupied the right seat, was the pilot monitoring (PM).

While en route to CYYZ, the flight crew received automatic terminal information service (ATIS) information from the aircraft communications addressing and reporting system (ACARS), which stated that Runway 15R was being used for arrivals. The flight crew then conducted the category I (CAT I)[2] instrument landing system (ILS) approach briefing for that runway.

During the flight, the flight crew consulted the low-visibility-approach requirements section of the quick reference handbook (QRH) and determined that, given the lighting that was available, they would require a runway visual range (RVR) of at least 1800 feet to use Runway 15R at CYYZ. At the time, the RVR for Runway 15R was reported to be variable but decreasing, between 3000 and 5500 feet. The flight crew discussed the lack of centreline lighting on Runway 15R and the possibility of using the autoland[3] system if conditions worsened.

At 2355, while the aircraft was descending through 4600 feet above sea level (ASL), air traffic control (ATC) cleared it for the ILS approach to Runway 15R, which was flown using autopilot.

1 All times are Eastern Standard Time (Coordinated Universal Time minus 5 hours).

2 "*Operational CAT I*—Operation down to a minima of 200 ft [feet] DH [decision height] and an RVR [runway visual range] of 2600 ft with a high probability of success. (When RVR is not available, 1/2 SM [statute mile] ground visibility is substituted.)" (Source: Transport Canada, *Transport Canada Aeronautical Information Manual* [TC AIM], COM – Communications [13 October 2016], section 4.11.5.)

3 Autoland is a system that fully automates the landing procedure of an aircraft's flight, with the flight crew supervising the process. The system is capable of situating the aircraft in the touchdown zone on an instrument landing system (ILS) / precision approach without control input from the flight crew.

At 2359:52, ATC cleared the flight to land. The controller informed the crew that they should expect to see the lights once reaching minimums (200 feet above ground level [AGL]), and that the previous landing aircraft had reported that the weather conditions were as forecast.

At 0000:42, while descending through 1550 feet ASL (approximately 980 feet AGL), both flight crew members turned on their windshield wipers because the aircraft was flying through light to moderate rain.

At 0001:07, while descending through 1235 feet ASL (665 feet AGL) and in the final approach phase of the descent, the aircraft passed through a layer of wind shear, which the flight crew had anticipated. From that point until the aircraft touched down, the wind speed remained less than 5 knots.

As the aircraft passed through 1070 feet ASL (500 feet AGL), it was still in instrument meteorological conditions (IMC) and its approach was stable, with an airspeed of 138 knots and a heading of 147° magnetic (M).

In accordance with Air Canada's standard operating procedures, upon reaching 200 feet AGL, the PM called "Minimums" and the PF, who had the approach lights in sight, responded "Landing".

At 100 feet AGL, the PF disengaged the autopilot. At 90 feet AGL, the PF began to input small, but increasing, alternating roll commands on the sidestick.

At 0001:57, the aircraft crossed the displaced threshold at a height of 39 feet AGL; it was centred laterally on the localizer and horizontally on the glideslope. Until this point on the approach, the angle between the aircraft's longitudinal axis and the track over the ground was nearly zero.

At 0001:59, when the aircraft was descending through 26 feet AGL, the PF made a brief large right roll input (approximately 75% of maximum deflection) on the sidestick, and the aircraft responded by entering a 4° right bank. The aircraft heading began to increase slightly and the aircraft began to drift to the right of the runway centreline.

Approximately 1 second later, the PF reduced the thrust to idle.

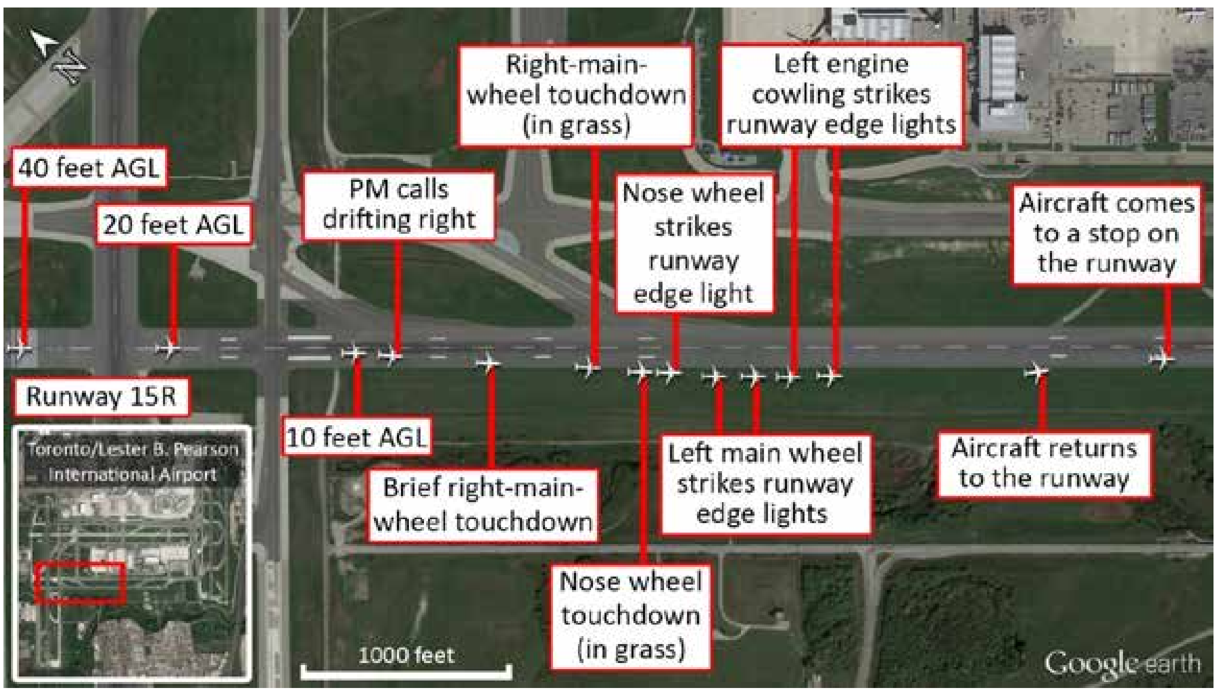
At 0002:05, at approximately 8 feet AGL, the aircraft was 32 feet to the right of the centreline, and the PM told the PF that the aircraft was drifting to the right. The PF acknowledged and input a left roll command and applied left rudder. The wings returned to level, although the drift to the right continued due to the aircraft's momentum.

At 0002:07, the left main wheels touched down on the runway surface, followed quickly by a very brief right-main-wheel touchdown, or skip. At this point, the aircraft was on the paved runway surface, 2227 feet from the displaced threshold and 64 feet to the right of the runway centreline. The outboard wheel of the right main gear was approximately 20 feet from the right runway edge. The aircraft continued drifting to the right following the skip, and when the right main wheels touched down again, they were approximately 8 feet to the right of the paved runway surface, in wet grass.

As the aircraft continued to move laterally to the right, the nose wheel touched down on the grass, approximately 280 feet beyond the final right-main-wheel touchdown point, and struck 1 runway edge light. The outboard left main wheel and left engine cowling then each struck 2 runway edge lights, and the outboard left tire was punctured and deflated.

The PF engaged reverse thrust, and the aircraft engines began to ingest debris. Once the speed had been reduced, the PF steered the aircraft back onto the paved runway surface, then came to a stop 5422 feet from the displaced threshold (Figure 1). The aircraft had travelled 2390 feet through the grass.

Figure 1. The aircraft's track from 20 feet AGL until it came to a stop on the runway (Source: Google Earth, with TSB annotations)



At 0002:33, the PM informed ATC that the aircraft was stopped on the runway, and the PF instructed the cabin crew and passengers to remain seated. A minute later, the PM informed ATC that the aircraft had undergone a runway excursion and requested assistance from aircraft rescue and firefighting (ARFF) personnel to inspect the aircraft for damage.

ARFF personnel arrived at 0009, and the aircraft was inspected and secured. At 0045, buses arrived, and the passengers were deplaned and transported to the terminal.

Injuries to persons

No injuries were reported.

Damage to aircraft

During the runway excursion, the outboard wheel of the left main landing gear was damaged and, as a result, the outboard left tire was punctured and deflated. The left nose-wheel tire was damaged, and the left engine cowling was dented. Both engines had ingested debris during the reverse thrust operation through the grass, and had to be replaced.

There was no noted damage to the tires from reverted rubber or marks on the runways surface which are typically associated with hydroplaning.

Other damage

During the runway excursion, 5 runway edge lights were damaged:

- 1 by the nose wheel;
- 2 by the left outboard main wheel; and
- 2 by the left engine cowling.

Personnel information

Qualifications

Records indicate that both flight crew members were certified and qualified for the flight in accordance with existing regulations.

Experience

The captain had been employed by Air Canada for 20 years and had accumulated over 18 000 hours of flight time, including 14 800 hours on A320 series aircraft, 2800 of which were as pilot-in-command.

The first officer had been employed by Air Canada for 11 years and had 11 500 hours of total flight time, including over 2700 hours on A320 series aircraft.

Training

The captain and the first officer had both received recurrent simulator training in the 3 months preceding the occurrence.

The Air Canada recurrent training syllabus includes practising missed-approach procedures and rejected landings following a loss of visual cues. Both pilots had completed this training syllabus without recorded difficulty.

Scheduling and rest

A fatigue-based analysis of the pilots' schedules was completed. There was no indication that fatigue was a factor in the occurrence for either flight crew member.

Aircraft information

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

Autopilot and autoland

The A320 is equipped with a flight guidance system and an autopilot, which includes an autoland mode. In autoland mode, the aircraft's autopilot controls the landing and rollout, and requires no direct control input from the flight crew.

In general, autoland is more often performed when weather is poor or when visibility is near the minima required to attempt the approach. Autoland is normally executed on CAT II[4] and CAT III[5] ILS approaches, as these approaches are better protected from potential signal interference. Autoland can also be executed on a CAT I approach. In this occurrence, because the reported RVR was almost double that which was required, the PF determined that an autoland was not necessary.

Go-around phase

During the go-around phase, the engines take some time to spool up to go-around thrust. As a result, "the pilot must be aware that the aircraft will initially lose some altitude. The altitude loss will be greater if initial thrust is close to idle and/or the aircraft speed is lower than VAPP [approach speed]."[6]

The loss of altitude is approximately 10 feet when the thrust is stabilized, but can reach up to 40 feet when the thrust is at idle power (Figure 2). As shown in the figure, if a go-around is initiated at idle thrust and approach speed, it may take up to 3 seconds to achieve a positive rate of climb, and up to 6 seconds to reach the altitude where the go-around was initiated.[7]

---

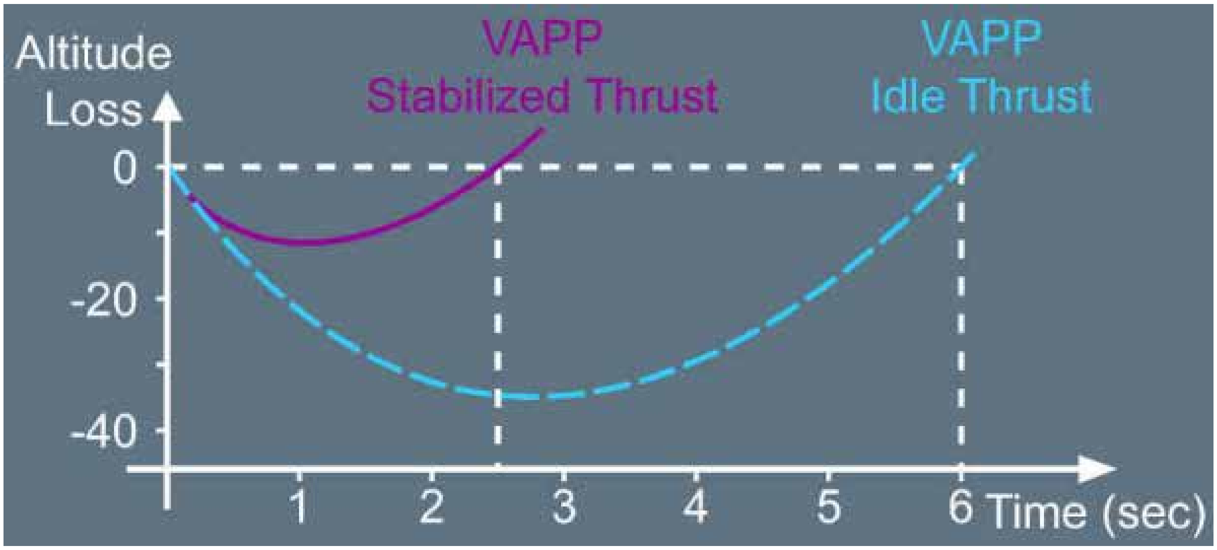
4 "*Operational CAT II.* Operation down to a minima below 200 ft [feet] DH [decision height] and an RVR [runway visual range] of 2600 ft, to as low as 100 ft DH and an RVR of 1200 ft, with a high probability of success." (Source: Transport Canada, *Transport Canada Aeronautical Information Manual* [TC AIM], COM – Communications [13 October 2016], section 4.11.5.)

5 "*Operational CAT III.* CAT III minima will be prescribed in the carrier's operating specifications, in the operator's operations manual, or in the CAP [*Canada Air Pilot*]." (Source: Ibid.)

6 Air Canada, *Airbus A319/A320/A321 Flight Crew Techniques Manual*, Normal Procedures, Standard Operating Procedures – Go-Around, Engines Acceleration (05 September 2017), p. PR-NP-SOP-260 P 4/6.

7 Ibid., p. PR-NP-SOP-260 P 5/6.

Figure 2. Altitude loss following a go-around (Source: Air Canada, *Airbus A319/A320/A321 Flight Crew Techniques Training Manual*, Normal Operations – Standard Operating Procedures – Go Around [05 September 2017], p. PR-NP-SOP-260 P 5/6.)



The Airbus flight crew training manual states that "the PF must not initiate a go-around after the selection of the thrust reversers."[8] If the aircraft is in a low-energy landing regime at the time of the go-around, the aircraft configuration should be maintained, and the flare procedure must be continued until the acceleration of the engines is sufficient to cause the aircraft to accelerate, before the crew pitches up the aircraft based on the flight-director command bars.[9]

Rain removal systems

Windshield wipers

The A320 is equipped with 2 individually controlled windshield wipers, 1 on each pilot's main windshield. The wipers have 3 settings: slow, fast, and off.

In general, wiper system performance can be affected by 2 factors: the condition of the wiper blade, and the amount of tension or pressure pressing the blade against the windshield.

Airbus and Air Canada do not have specific maintenance schedules that require periodic inspection of the wiper system on the A320; the system is inspected only if a defect is reported by a flight crew, or if the windshield is removed or replaced. Review of the Air Canada maintenance records for the occurrence aircraft determined that no recent inspections or maintenance had been performed on the wiper system.

---

8 Ibid., Go-Around Near the Ground, p. PR-NP-SOP-260, P 1/6.

9 Ibid.

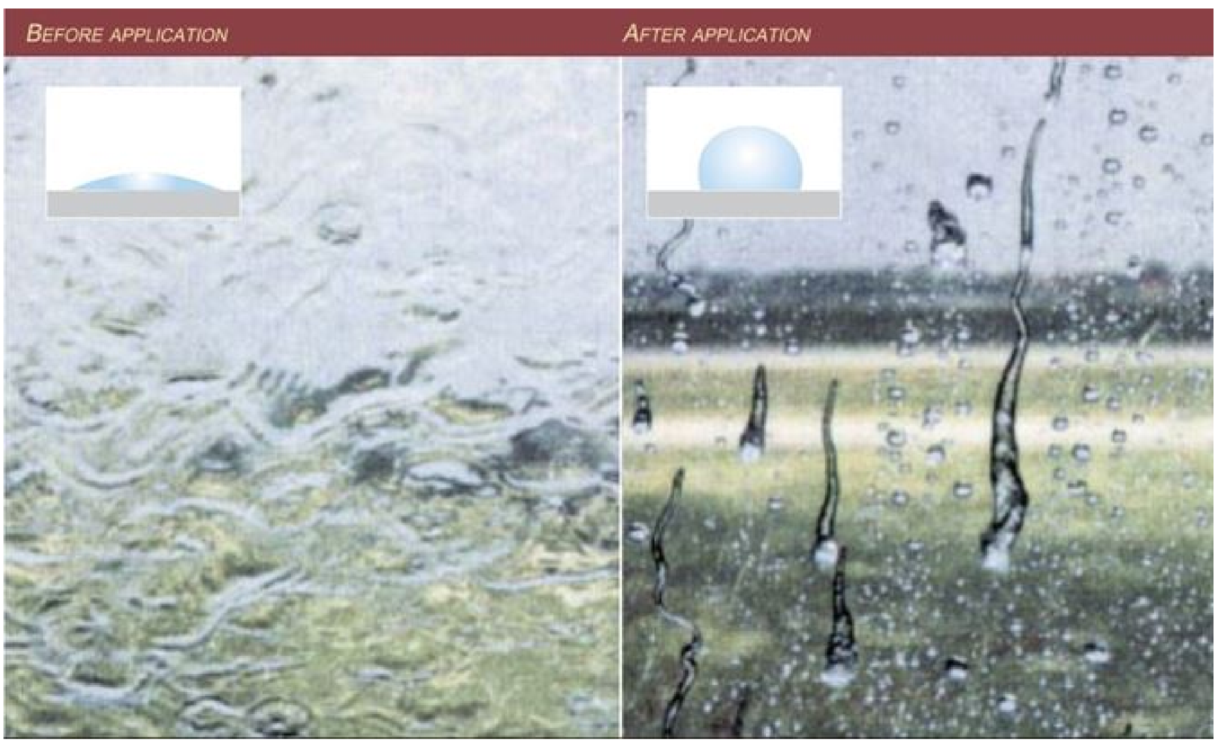
A post-occurrence inspection of the aircraft revealed that neither the left nor right wiper met the minimum specification for tension as outlined in the Airbus inspection procedure.[10]

Rain repellent system

When the occurrence aircraft was originally delivered to Air Canada in 1990, the manufacturer had equipped it with a rain repellent system. The system is designed for use in moderate to heavy rain. When either the pilot-in-command's or the co-pilot's rain repellent button is depressed, the system applies a predetermined quantity of rain repellent to that side of the windshield, and the repellent is distributed evenly over the external surface of the windshield.

The repellent is fast-acting and long-lasting, does not leave residue or create distortion, and restores visibility within a few seconds. The surface tension of the windshield is temporarily modified; coupled with airflow, this prevents drops of water from adhering to the windshield (Figure 3).

Figure 3. Illustration of the general effects of rain repellent at point of contact between drops of water and a windshield. (Source: Airbus Industrie, *FAST – Airbus Technical Digest*, Number 23 [October 1998], "Combining Environment Protection and Windshield Rain Protection on Airbus Aircraft", p. 23)



In January 1996, production, import, and export of the original rain repellent were prohibited for environmental reasons. In 1998, a new repellent fluid that complied with existing environmental regulations was made available to the aviation industry as a substitute. A

10 Air Canada, Maintenance Task 30-45-52 PB 401 CONF 00 – ARM – WIPER – REMOVAL/INSTALLATION (01 February 2017).

minor modification to existing rain repellent systems was required to make use of the new repellent.

Although the new repellent fluid was available, Air Canada had decided not to activate the rain repellent systems on its Airbus fleet.

Three previous TSB investigations[11] involving runway excursions examined the role played by the non-use or unavailability of rain repellent in each of the occurrences.

Hydrophobic coatings

For operators who wish to leave the rain repellent system deactivated, Airbus has formally approved the use of a hydrophobic coating developed by a third-party supplier for all of its aircraft types. The coating provides protection characteristics similar to those of the liquid repellent. Airbus Service Information Letter 30 024, published in July 1997, provides information on the coating and how to obtain it, as well as recommendations regarding application and maintenance.

At the time of report writing, Air Canada had not equipped its A320 fleet with hydrophobic coatings. However, it was testing hydrophobic coatings on other aircraft types within its fleet to determine their viability.

Meteorological information

Pre-flight

While waiting to depart from CYHZ, the crew received updated weather information for the planned flight and arrival in CYYZ. The forecasted conditions for the updated arrival time in CYYZ included thunderstorms, low ceilings, reduced visibility, and wind shear below 1000 feet AGL.

A CYYZ aerodrome special meteorological report (SPECI) issued 19 minutes before departure indicated that the wind was from 120° true (T) at 8 knots, the visibility was ¾ statute mile (sm) in mist, and the vertical visibility was 200 feet AGL.

A CYYZ SPECI issued 12 minutes before departure indicated that the wind was from 090°T at 7 knots, the visibility was ½ sm in fog, and the vertical visibility was 100 feet AGL.

En route and approach

Once en route, the crew received regular weather updates through the aircraft communications addressing and reporting system (ACARS). The weather was essentially as expected. The low ceiling and reduced visibility conditions in CYYZ remained.

---

11 TSB aviation investigation reports A05H0002, A10F0012, and A14Q0155.

At 2315, the flight crew received the CYYZ aviation routine weather report (METAR) for CYYZ, issued at 2300, which indicated that the wind was from 120°T at 6 knots, the visibility was ½ sm in fog, and the vertical visibility was 200 feet AGL. The RVR for Runway 15R was recorded as 3000 feet variable to 5500 feet; however, it was trending downward.

During the descent, at 2332 (30 minutes before touchdown), the flight crew received the automatic terminal information service (ATIS) message from the ACARS. The message, which had been issued at 2300, stated that the arrival runway was still Runway 15R, the wind was from 110°T at 3 knots, the visibility was ½ sm in fog, and the vertical visibility was 200 feet AGL.

At 2354 (8 minutes before touchdown), the flight crew received new ATIS information, which included the 2329 SPECI and indicated that the wind was from 120°T at 3 knots, the visibility was 3/8 sm in fog, and the vertical visibility was 100 feet AGL.

The CYYZ METAR issued at 0000 (2 minutes before touchdown) indicated that the wind was variable at 2 knots; the visibility was 3/8 sm in light thunderstorms, rain and fog; and the vertical visibility was 100 feet AGL. The RVR for Runway 15R was recorded at 3500 feet and trending upwards. However, the crew did not receive this METAR because it was issued just before the aircraft was to land.

During the initial stages of the approach, the wind at the aircraft's altitude was from 190°T at 46 knots. However, as the aircraft descended on the approach, the wind decreased significantly. When ATC cleared the flight to land, ATC informed the flight crew that the surface wind was variable, but was presently showing 200°M at 4 knots, and the RVR was 3000 feet.

Post-occurrence weather analysis

Following the occurrence, several other flight crews who were operating on the ground at CYYZ at the time of the occurrence submitted or were requested to submit weather observations from the period during the event. The visibility reported by these crews was less than 3000 feet of RVR.

A post-occurrence weather analysis was completed by Environment and Climate Change Canada. The analysis determined that the wind conditions were similar to those reported by ATC at the time. The analysis could not determine whether the visibility or RVR differed from that which had been originally reported.

Aids to navigation

The flight crew flew the ILS approach to Runway 15R. There were no reported anomalies in the approach or its associated systems.

Communications

The flight crew communicated effectively with various ATC agencies during the flight, and the content of those communications did not contribute negatively to the occurrence.

Aerodrome information

Runway selection

The most commonly used runways at CYYZ are the 3 parallel east/west runways: 05/23, 06R/24L, and 06L/24R. This east/west operation allows for the most operational flexibility and the greatest capacity.

During the evening of the occurrence, low-level wind shear in the CYYZ area was causing difficulties for the east/west operation, which resulted in several aircraft executing missed approaches. To reduce these difficulties, ATC elected to switch to a southbound operation with departures from Runway 15L and arrivals on Runway 15R. The switch occurred approximately 3 hours before the occurrence.

Of the available approaches to Runway 15R, the CAT I ILS approach has the least restrictive weather minima. Other runways at CYYZ have CAT II and III ILS approaches and therefore have less restrictive weather minima than the least restrictive weather minima for Runway 15R. However, given that the low-level wind shear was still prevalent during the time of the occurrence, aircraft were not executing go-arounds, and the visibility was sufficient for approaches on Runway 15R, ATC considered this approach to be the most suitable option.

Runway characteristics

Runway 15R at CYYZ is 197 feet (60 m) wide and 9088 feet (2770 m) long. The landing distance available is 8500 feet. At the edges of the runway width, there is a direct transition from paved surface to grass. Runway 15R/33L was initially designed, built, and certified by Transport Canada. Ownership was transferred to the Greater Toronto Airport Authority (GTAA) on 02 December 1996.

Paint markings

The runway is painted as per the specifications outlined in Transport Canada's *Aerodrome Standards and Recommended Practices* (TP 312), including touchdown zone, aiming point and runway centreline markings.

In rainy conditions, water can form a film on the runway markings, making them more difficult to see, especially at night.

Lighting

Runway 15R is equipped with the following lights:

- Simplified short approach lighting system with runway alignment indicator lights

- Runway threshold lights
- Runway end lights
- High-intensity runway edge lights
- Precision approach path indicator lights

Runway 15R/33L is the only runway at CYYZ that is not equipped with runway centreline lighting, nor was it required to be so equipped.

The runway edge lights are installed every 197 feet (60 m) along both sides of the runway, in the grassy area approximately 1.5 m from the runway edge, and at equal distances from the centreline.

When Runway 15R was certified, the lighting installed on the runway complied with the standards required in the 4th edition of TP 312, which was in effect at the time of certification. In addition to the standards, the 4th edition included recommendations. With regard to runway lighting, it recommended the following:

> Runway centre line lights should be provided on a precision approach runway category I, particularly when the runway is used by aircraft with high landing speeds or where the width between the runway edge lights is greater than 50 m.[12]

However, this recommendation was not the standard and was intended only as advisory information. In the current version of TP 312 (the 5th edition), recommendations have been removed and the document includes only the standards; there is no standard that would require centreline lighting on Runway 15R.

The International Civil Aviation Organization's (ICAO) Annex 14 to the Convention on International Civil Aviation, which is the international guide for runway construction, continues to include recommendations. Annex 14 includes the following:

> **Recommendation.**— Runway centre line lights should be provided on a precision approach runway category I, particularly when the runway is used by aircraft with high landing speeds or where the width between the runway edge lights is greater than 50 m.[13]

ICAO's *Aerodrome Design Manual* expands on the usefulness of centreline lighting, stating that

> The function of the centre line lighting is to provide the pilot with lateral guidance during the flare and landing ground roll or during a take-off. In normal circumstances, a pilot can maintain the track of the aircraft within

---

12 Transport Canada, TP 312, *Aerodrome Standards and Recommended Practices*, 4th Edition (March 1993), section 5.3.13.2.

13 International Civil Aviation Organization (ICAO), Annex 14 to the Convention on International Civil Aviation — Aerodromes, Volume 1 — *Aerodrome Design and Operations*, Seventh Edition (July 2016), section 5.3.12.2.

> approximately 1 to 2 m of the runway centre line with the aid of this lighting cue. The guidance information from the centre line is more sensitive than that provided from the pilot's assessment of the degree of asymmetry between the runway edge lighting. In low visibility conditions, the use of the centre line is also the best means of providing an adequate segment of lighting for the pilot to use. The greater distances involved in viewing the runway edge lighting together with the need for the pilot to look immediately ahead of the aircraft during the ground roll also contribute to the requirements for a well-lit runway centre line.[14]

Organizational and management information

Operator-required visual references

According to Air Canada's *Flight Operations Manual*,

> The required visual reference to continue the approach and landing and shall include at least one of the following references distinctly visible and identifiable for the intended runway:
>
> a) The runway or runway markings; or
>
> b) The runway threshold or threshold markings; or
>
> c) The touchdown zone or touchdown zone markings; or
>
> d) The approach lights; or
>
> e) The approach slope indicator system (VASI [visual approach slope indicator] or PAPI [precision approach path indicator]); or
>
> f) The runway identification lights; or
>
> g) The threshold and runway end lights; or
>
> h) The touchdown zone lights; or
>
> i) The parallel runway edge lights; or
>
> j) The runway centerline lights.[15]

Further, the manual states that a go-around must be initiated in the following cases:

> 1. The aircraft has reached the DH/DA [decision height / decision altitude] or MDA [minimum descent altitude] and the required visual reference is not established or is lost after descending below DH, DA, or MDA; or

---

14 International Civil Aviation Organization (ICAO), *Aerodrome Design Manual* (Doc 9157 AN/901), Part 4 – Visual Aids, Fourth Edition (2004), section 16.4.12.

15 Air Canada, *Flight Operations Manual*, Revision 27 (10 February 2014), Approach – Definitions, section 8.11.1, p. 77.

2. If a safe landing cannot be accomplished within the touchdown zone and the aircraft stopped on the runway[16]

Air Canada recognizes that the risk of losing visual references is greater during an approach in low-visibility conditions and in the absence of runway touchdown zone lighting and runway centreline lighting. Pilots are reminded that a go-around must be initiated immediately "if adequate visual reference is lost after the aircraft has descended below the DA [decision altitude], or the MDA."[17]

During the occurrence landing, the flight crew maintained visual contact with the parallel runway edge lights throughout the event.

Low-energy landing regime

According to Air Canada's *Aircraft Operating Manual*,

> The low-energy landing regime is defined as:
>
> - aircraft flaps and landing gear are in the landing configuration,
> - aircraft is in descent,
> - thrust has stabilized in the idle range,
> - airspeed is decreasing,
> - aircraft height is 50 ft or less above the runway elevation.[18]

In addition, the manual states, "The decision to place an aircraft into the low energy landing regime is a decision to land."[19] Go-around during a low-energy landing regime is an interrupted landing and could lead to contact with the ground. Nonetheless, according to Airbus, a go-around is still possible as long as the thrust reversers have not been deployed; temporary landing gear contact with the runway is acceptable.

Additional information

Similar occurrences

The TSB has previously investigated a number of lateral runway excursions[20] in which directional control issues developed during the visual segment prior to aircraft touchdown. These occurrences had several commonalities:

---

16 Ibid., Go-Around, section 8.11.9.2, p. 77.

17 Air Canada, *Flight Operations Manual*, Risk Associated with Low Visibility Approaches, Revision 27 (10 February 2014), section 8.11.13.4, p. 87.

18 Air Canada, *A319-A320-A321 Aircraft Operating Manual*, Abnormals, Low-Energy Go-Around (01 July 2013), p. 1.02.10 P20.

19 Ibid.

20 TSB aviation investigation reports A91A0198, A93W0037, A03A0012, A04W0032, A05W0010, A05C0222, A10F0012, and A14Q0155.

- All involved CAT I ILS approaches.
- All approaches were conducted during conditions of degraded visibility.
- None of the runways involved were equipped with operable centreline lighting.
- At DH, all of the crews had the required visual reference to continue the approach, but did not have sufficient visual cues to maintain alignment with the runway until touchdown.
- All but 1 approach[21] were conducted during the hours of darkness.
- All but 1 approach[22] were to runways that were 197 feet (60 m) wide.

Airbus conducted a review of 31 lateral runway excursions that occurred during landing between 2012 and 2014. The results of the review, published in *The Airbus Safety Magazine*, noted that it is not unusual for pilot actions to destabilize the aircraft trajectory late in the approach:

> Experience shows that in some situations, some pilots have tendencies to destabilize the approach trajectory, especially along the lateral axis. It happens mainly in these 3 cases:
>
> - When disconnecting the Auto Pilot (AP) for a manual landing.
> - When initially becoming visual below a low cloud ceiling.
> - When performing the decrab in the flare.[23]

The review stopped short of explaining why these tendencies exist, but pointed out that, since the aircraft is stable while flying on the autopilot, no sidestick inputs should be made until the pilot has had time to analyze aircraft trajectory.

Tests and research

TSB laboratory reports

The TSB completed the following laboratory report in support of this investigation:

- LP030/2017 – FDR (flight data recorder) Download and Analysis

---

21 The only daytime occurrence (A14Q0155) happened during heavy rain when the runway and approach lights were unserviceable.

22 The only investigation involving a runway that was not 197 feet (60 m) wide (A10F0012), occurred in Cuba.

23 M. Mayolle, S. Pellet and X. Lesceu, "Lateral runway excursions upon landing," in: *Safety First: The Airbus Safety Magazine* (July 2015), p. 22.

Analysis

General

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The flight crew were certified and qualified for the flight in accordance with existing regulations, and there were no indications that the flight crew's performance was degraded as a result of physiological factors, such as fatigue.

The analysis will therefore focus on weather, aircraft systems, and runway lighting and environment, and how those factors reduced the cues available for the crew to recognize the drift in sufficient time to correct for it or to carry out a safe go-around.

Weather

Wind

Although there was low-level wind shear in the area through which the aircraft transited during final descent, by the time the aircraft was below 500 feet above ground level (AGL) on approach, the wind had decreased to less than 5 knots, and the aircraft's trajectory and speed were stable.

From this point until the pilot flying's (PF's) right roll control input, the angle between the aircraft's longitudinal axis and the track over the ground was nearly 0, indicating there was no into-wind crab angle being applied and no significant lateral wind component.

Because the aircraft's lateral movement was consistent with recorded control inputs, it was determined that a variation in wind speed or direction was not the cause of the aircraft's lateral deviation.

Visibility

The various weather reports received by the crew in the hour preceding the approach described the visibility as between 3/8 statute miles (sm) and ½ sm in fog. The runway visual ranges (RVRs) for Runway 15R were reported to be as low as 3000 feet, but occasionally variable up to 5500 feet.

While issuing the flight's landing clearance approximately 2 minutes before touchdown, air traffic control (ATC) informed the flight crew that the RVR was 3000 feet.

The occurrence flight crew and a few other flight crews that were operating on the ground at Toronto/Lester B. Pearson International Airport (CYYZ) at the time of the occurrence perceived the actual visibility to be not as high as the visibility recorded and reported by ATC. However, the reason for this disparity could not be determined.

If the visibility was in fact less than reported, it would have reduced the visual cues available to the flight crew to accurately assess their position.

Rain

Light to moderate rain was falling at the time of the landing and, as a result, the runway surface was wet. Although wet runway surfaces or standing water can lead to hydroplaning and have caused or contributed to runway excursions in the past, no evidence was found to suggest that hydroplaning was a factor in this occurrence.

Although hydroplaning did not occur, the rain did have an effect on the occurrence. The film of water on the runway surface during hours of darkness would have degraded the visibility of the runway paint markings, and the effects of rain on the windshield would have reduced the clarity of the flight crew's view through the cockpit windows.

Aircraft

Windshield wipers

A post-occurrence inspection found that the windshield wipers did not meet the minimum specification for tension. There are currently no scheduled maintenance activities that require inspection of the windshield wiper system.

The degraded performance of the wipers could have reduced the flight crew's forward visibility while flying through the precipitation on final approach and during the flare.

Rain repellent system

When the occurrence aircraft was manufactured, Airbus equipped it with a rain repellent system to reduce the effects of rain on forward visibility. The rain repellent system is a recognized system that acts quickly to restore visibility within a few seconds.

Several years ago, this system was deactivated on all applicable Air Canada aircraft due to the hazard that the original repellent fluid posed to the environment. Since that time, a substitute fluid that is acceptable from an environmental standpoint became available to operators. However, at the time of the occurrence, the rain repellent system on the occurrence aircraft had not been restored to service.

Three previous TSB investigations[24] involving runway excursions examined the role played by the non-use or unavailability of rain repellent in each of the occurrences.

In this occurrence, it was not possible to establish whether the rain repellent system would have enabled the PF to maintain visibility through the windshield sufficient to keep the aircraft on the runway centreline. However, there is an increased risk that visual cues may be reduced while flying in precipitation if fitted rain repellent systems are not used.

---

24 TSB aviation investigation reports A05H0002, A10F0012, and A14Q0155.

Runway

Runway lighting

Although Runway 15R complies with the regulatory standards for runway lighting, it does not follow the recommendations outlined in the edition of Transport Canada's *Aerodrome Standards and Recommended Practices* (TP 312) that was in effect at the time of certification, or the recommendations in the current edition of the International Civil Aviation Organization's Annex 14 to the Convention on International Civil Aviation.

These recommendations call for centreline lighting when the runway edge lights are spaced more than 50 m apart. On Runway 15R, the spacing is 63 m. On runways without centreline lighting, as the distance between runway edge lights increases, it becomes more difficult to judge lateral movement solely by assessing the degree of asymmetry between the runway edge lights—especially when the aircraft is close to the ground and the flight crew's attention is focused directly ahead of them.

The TSB has investigated a number of lateral runway excursions[25] that occurred on runways without centreline lighting. If the distance between runway edge lights is greater than 50 m and runways are not equipped with centreline lighting, there is a risk that visual cues will be insufficient for flight crews to detect lateral drift soon enough to prevent an excursion, while operating aircraft at night during periods of reduced visibility.

Drift

Onset

During the approach, the aircraft was stable with regard to speed, vertical glide path, and attitude, and was on the correct lateral path until it was approximately 26 feet AGL. Once thrust was reduced to idle, the PF's attention was focused outside of the aircraft in preparation for touchdown.

For undetermined reasons, during the transition to flare, while the aircraft was on the runway centreline, the PF made a right roll command input, which resulted in the aircraft entering a shallow right bank and beginning to drift to the right.

Although a previous review of lateral excursions by Airbus Industrie found that this type of destabilization often occurred during the disconnection of autopilot or the transition to visual approach, the destabilization in this occurrence took place significantly later and closer to the ground.

---

[25] TSB aviation investigation reports A91A0198, A93W0037, A03A0012, A04W0032, A05W0010, A05C0222, A10F0012, and A14Q0155.

Recognition

The flight crew had limited visual cues available to accurately judge the aircraft's lateral position given the weather conditions, reduced windshield wiper capability, and lack of runway centreline lighting.

Once over the runway surface, the flight crew had to judge the aircraft's lateral position based solely on their assessment of the degree of asymmetry between the runway edge lights. As a result, the onset of drift was not initially noticed.

The pilot monitoring (PM) ultimately noticed the drift after it became significant and alerted the PF. However, the severity of the drift was not recognized until the aircraft was less than 10 feet AGL and rapidly approaching the runway edge, leaving limited time to correct the aircraft's trajectory before the aircraft contacted the surface.

Reaction

Despite the drift, the PF initially felt that it was still possible to land on the runway surface and made control inputs to return the wings to level; however, this correction was insufficient to counteract the aircraft's lateral momentum.

Two seconds after the inputs were made, the main wheels made initial contact with the ground, and the PF recognized the severity of the drift and the likely runway excursion. At this point, there remained only 2 options: to execute a go-around, or to continue the landing sequence and attempt to minimize the extent of the excursion.

The aircraft was in a low-energy state, as the thrust had already been reduced to idle. A go-around from this point, although possible, would have included an uncertain period of time travelling on the ground on a surface outside of the runway dimensions.

A go-around executed from a low level in response to significant drift may lead to contact with obstacles outside of the runway area, potentially causing damage to the aircraft. If the aircraft is damaged and then becomes airborne, executing the go-around may end up being more dangerous than continuing the landing from the same position.

In this occurrence, once the flight crew recognized that the aircraft would exit the paved runway surface, the PF continued the landing roll as opposed to executing a go-around following contact with unknown terrain and objects.

Findings

Findings as to causes and contributing factors

1. For undetermined reasons, during the transition to flare, while the aircraft was on the runway centreline, the pilot flying made a right roll command input, which resulted in the aircraft entering a shallow right bank and beginning to drift to the right.

2. The flight crew had limited visual cues available to accurately judge the aircraft's lateral position given the weather conditions, reduced windshield wiper capability and lack of runway centreline lighting.

3. Once over the runway surface, the flight crew had to judge the aircraft's lateral position based solely on their assessment of the degree of asymmetry between the runway edge lights. As a result, the onset of drift was not initially noticed.

4. The severity of the drift was not recognized until the aircraft was less than 10 feet above ground level and rapidly approaching the runway edge, leaving limited time to correct the aircraft's trajectory before the aircraft contacted the surface.

5. Once the flight crew recognized that the aircraft would exit the paved runway surface, the pilot flying continued the landing roll as opposed to executing a go-around following contact with unknown terrain and objects.

Findings as to risk

1. There is an increased risk that visual cues may be reduced while flying in precipitation if fitted rain repellent systems are not used.

2. If the distance between runway edge lights is greater than 50 m and runways are not equipped with centreline lighting, there is a risk that visual cues will be insufficient for flight crews to detect lateral drift soon enough to prevent an excursion, while operating aircraft at night during periods of reduced visibility.

Safety action

Safety action taken

Air Canada

In May 2017, Air Canada Maintenance instituted a program for windshield wiper tension inspection.

A drift training scenario has been developed in the simulator, which now provides pilots with examples of approaches that become unstable in the flare. One of the scenarios requires the pilot monitoring to use the priority takeover button to commence the go-around. Pilots began receiving this training in June 2017.

Bulletins have been published for pilots:

- Flight Ops Safety Source – Lateral Drift in the Flare Guidance Material;
- Flight Ops Safety Source – Lateral Runway Excursions; and
- ATB 544 – Revision to Flight Control Take-over.

Current testing of hydrophobic coatings has been expanded to 2 narrow-body Airbus aircraft.

A 90-day crew alert was published for pilots, providing information to flight crews to straddle the centreline on landing.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 28 March 2018. It was officially released on 25 April 2018.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.