Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A01A0028

RUNWAY OVERRUN

ROYAL AVIATION INC.
BOEING 737-200 C-GDCC
ST. JOHN'S INTERNATIONAL AIRPORT, NEWFOUNDLAND
04 APRIL 2001

Canada

Aviation Investigation Report

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Summary

The Boeing 737-200 cargo aircraft, C-GDCC, serial number 20681, with two pilots on board was on the instrument landing system approach for Runway 16 at St. John's International Airport, Newfoundland. After touching down, the aircraft continued off the end of the runway and came to rest in deep snow approximately 75 feet from the departure end. The two pilots were uninjured; the aircraft was substantially damaged.

Ce rapport est également disponible en français.

Other Factual Information

At 2320, Newfoundland daylight time[1], on 03 April 2001, the Royal Cargo flight, a Boeing 737-200, left Mirabel, Quebec, for a scheduled instrument flight rules cargo flight with two pilots on board. The flight was headed for Hamilton, Ontario; Mirabel; Halifax, Nova Scotia; St. John's, Newfoundland; and Mirabel. The flights from Mirabel to Halifax were uneventful. Before departure from Halifax, the pilot flying (PF) received the latest weather information for the flight to St. John's from the company dispatch; he did not ask for, or receive, the latest notices to airmen (NOTAMs). At 0545, the aircraft departed Halifax for St. John's. The PF was completing his line indoctrination training after having recently upgraded to captain.

The training captain, who was the pilot not flying (PNF), occupied the right seat. After departure from Halifax, he contacted Halifax Flight Service Station (FSS) and received the latest weather report for St. John's, the 0530 aviation routine weather report (METAR). The weather was as follows: wind 050° magnetic (M) at 35, gusting to 40, knots; visibility 1 statute mile in light snow and blowing snow; ceiling 400 feet overcast; temperature -1°C; dew point -2°C; and altimeter 29.41 inches of mercury. The FSS passed runway surface condition (RSC) reports for both runways (11/29 and 16/34), including Canadian runway friction index (CRFI) readings of 0.25 for Runway 11/29 and 0.24 for Runway 16/34. The FSS specialist also provided the NOTAMs for St. John's, which included a NOTAM released more than five hours earlier advising of the unserviceability of the instrument landing system (ILS) for Runway 11. The flight crew had initially planned an ILS approach, landing on Runway 11 at St. John's. Because of the marginal weather, the loss of Runway 11/29, and his greater experience, the training captain decided to switch seats and assume the duties and full responsibilities as captain and PF. Returning to Halifax was not considered because the aircraft would be overweight for landing there. The option of diverting the flight to the alternate airport was also discussed by the crew; however, in the end, they felt that a safe landing was achievable in St. John's.

At 0638:27, the PF contacted St. John's tower to ask if the approach to Runway 34 was still an option. The response indicated that Runway 34 was probably the only option because of the wind: 050°M (estimated) at 35, gusting to 40, knots. The ILS on Runway 11 was unserviceable, and the glidepath for Runway 29 was unserviceable. The only instrument approaches available were the localizer back course Runway 34 and the ILS Runway 16. Also, at about 0638, the Gander Area Control Centre (ACC) controller suggested to the crew that they obtain the 0630 automatic terminal information service (ATIS) for St. John's. The ATIS was reporting surface winds of 055°M at 20, gusting to 35, knots. The PNF attempted to obtain the ATIS information; however, because of a simultaneous radio transmission on the second VHF radio between the PF and St. John's tower, the ATIS information was not obtained.

At 0641, the PNF contacted Gander ACC, which reported the winds at St. John's as 040°M at 13, gusting to 18, knots. The PNF pointed out the discrepancy in the two wind reports to the PF; however, there was no acknowledgement of the significance of the discrepancy. It was later determined that the discrepancy was an unserviceable anemometer at the St. John's airport due

[1] All times are Newfoundland daylight time (Coordinated Universal Time minus two and one-half hours).

to ice accretion on the anemometer. The anemometer was providing a direct reading of the incorrect wind information to Gander ACC. Gander ACC was unaware of the unserviceability and unknowingly passed the incorrect wind information on to the flight crew.

At 0644, Gander ACC transmitted a significant meteorological report (SIGMET), issued at 0412 and valid from 0415 to 0815, that included St. John's. The SIGMET forecast severe mechanical turbulence below 3000 feet due to surface wind gusts in excess of 50 knots. However, the crew may not have been listening to the SIGMET broadcast: while the ACC transmitted the SIGMET, the crew were discussing the application of an 18-knot quartering tailwind for the approach to Runway 16. This tailwind was well under the 50 knots described by the SIGMET. The crew did not acknowledge receipt of the SIGMET until prompted by the controller.

Before the descent into St. John's, the crew discussed approach options. The approach to Runway 11 was discounted because of the unserviceability of the ILS, and Runway 34 was eliminated as an option because the weather was below its published approach minimums. The crew discussed the ILS approach to Runway 16. Although the PNF expressed concern about the tailwind, it was decided to attempt the approach because the wind reported by Gander ACC was within the aircraft's landing limits. In calculating the approach speed in preparation for the approach, there was confusion during the application of the tailwind and gust corrections to the landing reference speed (V_{ref}). The crew had correctly established a flap-30 V_{ref} of 132 knots indicated airspeed (KIAS) and ultimately an approach speed of 142 KIAS. The approach speed calculations were derived using the incorrect wind information from Gander ACC; further, the crew added five knots for the gust increment to the nominal approach speed (V_{ref} + 5 knots), that is, V_{ref} + 10 knots. This incorrect calculation (adding the gust factor) was consistent with company practice at the time of the accident. During the descent, the crew also had difficulty completing the descent and approach checklists; there were several missteps and repeated attempts at completion of checks.

Clearance for an ILS approach to Runway 16 was obtained from Gander ACC , and the crew was advised to contact St. John's tower. Just over two minutes before landing, the tower advised that the wind was 050°M (estimated) at 20, gusting to 35, knots and provided the following RSC report for Runway 16:

> Full length 170 feet wide, surface 30% very light dusting of snow and 70% compact snow and ice; remainder is 20% light snow, 80% compact snow and ice, windrow along the east side of the runway; friction index 0.20; and temperature -1°C at 0925.

The aircraft crossed the final approach fix on the ILS glideslope at 150 KIAS. During the final approach, the airspeed steadily increased to 180 KIAS (ground speed 190 knots); the glidepath was maintained with a descent rate of 1000 feet per minute.

From 1000 feet above sea level, no airspeed calls were made; altitude calls were made and responses were made. The Royal Boeing 737 operations manual states that the PNF shall call out significant deviations from programmed airspeed. In the descent, through 900 feet above sea level, the aircraft encountered turbulence resulting in uncommanded roll and pitch deviations and airspeed fluctuations of ±11 knots. At about 300 feet above decision height, the crew acquired visual references for landing.

Approximately one minute before landing, St. John's tower transmitted the runway visual range, repeated the estimated surface wind (050°M [estimated] at 20, gusting to 35, knots), and issued a landing clearance to the aircraft; the PNF acknowledged this information.

The aircraft touched down at 164 KIAS (27 KIAS above the desired touchdown speed of V_{ref}), 2300 to 2500 feet[2] beyond the threshold. Radar ground speed at touchdown was 180 knots. The wind at this point was determined to be about 050°M at 30 knots. Shortly after touchdown, the speed brakes and thrust reversers were deployed, and an engine pressure ratio (EPR) of 1.7 was reached 10 seconds after touchdown. Longitudinal deceleration was -0.37*g* within 1.3 seconds of touchdown, suggesting that a significant degree of effective wheel braking was achieved. With approximately 1100 feet of runway remaining, through a speed of 64 KIAS, reverse thrust increased to about 1.97 EPR on engine 1 and 2.15 EPR on engine 2. As the aircraft approached the end of the runway, the captain attempted to steer the aircraft to the right, toward the Delta taxiway intersection. Twenty-two seconds after touchdown, the aircraft exited the departure end of the runway into deep snow. The aircraft came to rest approximately 75 feet beyond and 53 feet to the right of the runway centreline on a heading of 235°M.

Personnel Information

Both crew members were certified and qualified for the flight in accordance with existing regulations. Before the accident, both pilots had been on duty for approximately nine hours, which was within the limits set by regulations. It was reported that the training captain, after eight hours of rest, had been awake for two hours before reporting for duty and that the trainee captain, after approximately three hours of rest, had been awake for five hours before reporting for duty. The night before the accident flight, both crew members had operated the same series of flights as those planned for the night of the accident flight, starting and ending at Mirabel. They had 11 hours free from duty between the flights. Both crew members had three days off prior to flying these two series of night flights.

Meteorological Information

At the time of the accident, a low-pressure system was centred approximately 180 nautical miles south of St. John's. The aerodrome forecast (TAF) for the airport indicated high winds and low ceiling/visibility in light snow and blowing snow.

The St. John's 0630 METAR reported similar weather conditions as those forecast in the TAF, with surface winds 050°M at 20, gusting to 35, knots. The surface wind information was estimated because of the failure of the anemometer at the airport; it was unserviceable from 0200 until after the accident. The term "estimated" was not included in the 0530 and 0630 METARs for St. John's.

The wind information passed to the crew from Gander ACC was incorrect: the surface wind information from the Gander low-level controller was a direct readout from the failed anemometer in St. John's. The remainder of the information passed to the crew was from a display available to the controller; this displayed weather information did not include the fact that the surface wind for St. John's was estimated. An unwritten procedure called for the St. John's FSS specialist to inform the technical operations coordinator (TOC) at Gander ACC of

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[2] The touchdown point was derived from flight data recorder and radar data.

malfunctions; the TOC would in turn advise the controller. The FSS specialist did not inform the TOC of the anemometer failure and, therefore, the controller was unaware that the wind readout was invalid. The wind information passed tothe crew from St. John's control tower was acquired directly from the FSS specialist at St. John's and did include the word "estimated".

Aircraft Information

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The weight and centre of gravity were within the prescribed limits. The aircraft sustained substantial damage as a result of the impact with runway end lights and the deep, hard-packed snow at the end of Runway 16. Both engines had internal damage, and the left engine detached from the wing. The right main landing gear outboard tire ruptured following an impact with a runway end light.

The inboard tires on the left and right main landing gear exhibited tread abrasion damage around the entire circumference; the outboard tires did not exhibit tread damage. Why only the inboard tires showed abrasion damage is not clear; a possible explanation could be a difference between the efficiency of the inboard and outboard antiskid systems or differences in tire pressure. In addition, the aircraft had a relatively high deceleration rate after touchdown at St. John's before reverse thrust was applied. The effective wheel braking indicates that the aircraft was not hydroplaning.

Aircraft Landing Performance

The crew used the "Landing Performance on Slippery Runways, Flap 30" chart contained in the *Quick Reference Manual* to calculate the landing distance required. This chart is produced by the manufacturer and uses the airplane braking coefficient of friction (Mu_b) rather than the CRFI. Mu_b is not reported in Canada: therefore, to use the chart, the CRFI must be converted to an equivalent Mu_b. There was no readily available direct conversion reference for the crew, thus limiting the usefulness of this chart. The crew converted the CRFI value to Mu_b using a rule of thumb that divided the CRFI by two (.2 CRFI = .1 Mu_b).

Using the aircraft weight of 101 000 pounds and an estimated Mu_b, the crew calculated the zero-wind landing distance to be 4200 feet. The chart requires that 50 feet be added to the landing distance for each knot of tailwind. The captain had calculated a tailwind component of 10 knots, so 500 feet was added to the landing distance for a total of 4700 feet. The crew believed the runway length available for landing on Runway 16 to be 7500 feet, when the available length was 7000 feet.

The Boeing operations manual that was used by the operator states that a gust correction should be maintained to touchdown and that the minimum approach speed (V_{ref} + 5 knots) should be bled off to V_{ref} as the aircraft approaches touchdown. The manual also states that a wind correction should not be applied to V_{ref} for tailwinds. The importance of airspeed control when landing on slippery runways is emphasized in the manual. The occurrence crew and company training pilots believed that the steady-state tailwind component and the full gust should both be added to the approach speed.

Calculations by the manufacturer for a landing, using the accident aircraft landing weight, a Mu_b of .075 (equivalent to the reported CRFI), and a touchdown ground speed of 180 knots at the nominal touchdown point of 1000 feet, determined that the required stopping distance after touchdown would be approximately 5600 feet. The aircraft landing distance required would thus be 6600 feet. These calculations were verified in representative simulator flights. Landing with flap 40 would have improved the stopping performance of the aircraft by approximately 200 feet.

Flight Recorders

An L3 Communications cockpit voice recorder (CVR) and a Honeywell flight data recorder (FDR) were removed from the aircraft and sent to the TSB Engineering Laboratory for analysis. Both recorders were in good working order and provided good data.

Organizational and Management Information

At the time of the accident, Royal Cargo was operated under Royal Aviation Inc., which held an approved and valid air operator certificate. Royal Aviation operated the Boeing 737 in passenger and cargo configuration under Canadian Aviation Regulation 705—Airline Operations.

Two separate operational control systems, Type A and Type C, were in use. Passenger aircraft were dispatched under the Type A system, and cargo aircraft were dispatched under the Type C system. Under a Type A system, the flight is co-dispatched and the dispatcher must maintain a flight watch,[3] which includes keeping the pilot-in-command aware of all factors and conditions (such as pertinent NOTAMs) affecting the flight. The occurrence flight, which was under a Type C operational control, was pilot self-dispatched and, as such, was subject to only flight following[4] by the dispatcher. Company direction to dispatchers did, however, state that company operations were to update weather and NOTAMs "only when major changes occur and/or a change of forecast."

Fatigue

Overnight flights involve disruptions to sleep patterns and are known to induce fatigue. Further, the time of day that a person works and a person's biological clock are known to have a far greater effect on alertness than the number of consecutive hours worked. Lowest alertness occurs between 0300 and 0500, and increased fatigue will normally decrease alertness. The level of alertness determines how well a person performs tasks. When the crew departed Halifax, their level of fatigue was likely at its highest and alertness at its lowest.

Known indicators of fatigue and reduced alertness include change in mood, forgetting or ignoring normal checks or procedures, reduced attention, overlooking or misplacing sequential task elements, becoming preoccupied with single tasks or elements (mindset), and willingness to take risks that would not normally be tolerated when alert. Fatigued persons are also less

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3 *Flight watch* means maintaining current information on the progress of the flight and monitoring all factors and conditions that might affect the operational flight plan.

4 *Flight following* means monitoring a flight's progress, providing operational information requested by the pilot-in-command, and notifying the appropriate air operator and search-and-rescue authorities if the flight is overdue or missing. Meteorological information provided to the pilot-in-command by the flight follower shall not include analysis or interpretation.

vigilant and less aware of their below-standard performance and often don't recognize that they are tired and not performing well.

Analysis

Before departing Halifax, the trainee captain did not receive the updated NOTAMs for St. John's, nor was this information specifically requested. Although obtaining NOTAM information is a basic part of pre-flight planning, particularly when operating under a Type C operational control system, the company direction and expectation of the crew was that NOTAM updates would be provided if there was a major change. Once airborne, the training captain realized that the unavailability of Runway 11/19 significantly altered the landing conditions expected at St. John's. Because of his relatively higher level of experience, he elected to assume the full duties of captain and PF. There was some discussion of discontinuing the flight and diverting to the alternate airport. However, despite the loss of the ILS approach at St. John's and the requirement to land on a shorter runway in poor weather, this option was not discussed again for the remainder of the flight.

Landing performance planning by the flight crew was based on incorrect surface wind information. After the decision to approach and land on Runway 16, several transmissions were received and acknowledged, indicating that the surface winds were significantly stronger than those used. However, only once did the trainee captain question the captain about the discrepancy in wind reports, and this was either overlooked or disregarded by the captain. Ultimately, they used the most-favourable reported winds for planning the approach and landing on Runway 16.

In addition to using an incorrect wind for their approach and landing calculations, the crew applied an inappropriate correction to the approach and landing speeds to account for the tailwind. The crew considered compensation for the added stopping distance required for landing with the calculated tailwind. However, they did not appreciate that applying an inappropriate wind correction would result in carrying additional speed on approach and landing. This condition was exacerbated by the poorly controlled airspeed during the approach and at touchdown. The misunderstanding of the application of wind correction by an experienced crew and company training pilot, in a relatively mature airline, is a training and operating deficiency that was not detected by Transport Canada.

The landing distance calculations provided by the manufacturer confirmed that, even with the increased speed at touchdown, the aircraft should have stopped on the runway remaining if the touchdown point had been at its nominal point of 1000 feet past the threshold.

The crew displayed many of the symptoms typically associated with fatigue. Some of these, with examples, follow:

1. Reduced alertness: In spite of several indications of contradictory wind information, the crew was unable to establish the correct conditions.

2. Forgetting or ignoring normal checks or procedures: There was a lack of standard operating procedure airspeed calls during the final approach.

3. Overlooking or misplacing sequential task elements: The crew had difficulty completing approach and pre-landing checks and calculating approach speeds.

4. Mindset: The crew continued the flight to St. John's and unquestioningly accepted risks that likely would not have been acceptable to most crews. This is particularly exemplified by the crew's attempting to land in poor weather with a gusting tailwind on a contaminated, relatively short runway.

In summary, the crew performed below the standard expected of an experienced and trained crew. Although their performance was below standard, it could not be established that the crew members were in a fatigued state.

The following TSB Engineering Laboratory Report was completed:

LP023/2001—FDR/CVR Analysis.

Findings as to Causes and Contributing Factors

1. A combination of excessive landing speed, extended touchdown point, and low runway friction coefficient resulted in the aircraft overrunning the runway.

Findings as to Risk

1. Before departure from Halifax, the flight crew did not request nor did dispatch personnel inform the crew of the notice to airmen (NOTAM) advising of the instrument landing system's failure for Runway 11 at St. John's International Airport.

2. The St. John's dynamic wind information provided to the Gander Area Control Centre controller was inaccurate. The controller was not aware of this inaccuracy.

3. The crew applied tailwind corrections in accordance with company practices; however, these practices were not in accordance with those stated in the operations manual.

Safety Action

Nav Canada issued a station operations bulletin to all St. John's Flight Service Station personnel. The bulletin clarified the procedure for reporting estimated winds in an aviation routine weather report (METAR). Nav Canada also issued a bulletin to all units informing air traffic services personnel to be vigilant during icing conditions and the actions to be taken if they suspect the anemometer is affected by ice accretion.

Transport Canada, through correspondence with Nav Canada, has identified a safety deficiency concerning the degraded performance of anemometers due to ice accretion. Transport Canada has also requested that Nav Canada implement software changes that would suppress incorrect wind information under these conditions.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 19 May 2003.

Appendix A: Glossary

ACC	area control centre
ATIS	automatic terminal information service
CRFI	Canadian runway friction index
CVR	cockpit voice recorder
EPR	engine pressure ration
FDR	flight data recorder
FSS	flight service station
ILS	instrument landing system
KIAS	knots indicated airspeed
M	magnetic
METAR	aviation routine weather report
Mu_b	airplane braking coefficient of friction
NOTAM	Notice to Airmen
PF	pilot flying
PNF	pilot not flying
RSC	runway surface condition
SIGMET	significant meteorological report
TAF	aerodrome forecast
TOC	technical operations coordinator
V_{ref}	landing reference speed