AVIATION INVESTIGATION REPORT
A02A0030

LOSS OF DIRECTIONAL CONTROL AND
COLLISION WITH SNOWBANK

PROVINCIAL AIRLINES LTD.
FAIRCHILD METRO SA227-AC C-FITW
GOOSE BAY, NEWFOUNDLAND AND LABRADOR
04 MARCH 2002

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Summary

The aircraft was on a scheduled courier flight from St. John's, Newfoundland and Labrador, to Goose Bay. The aircraft touched down at 0456 Atlantic standard time and, during the landing roll on the snow-covered runway, the aircraft started to veer to the right. The captain's attempt to regain directional control by the use of full-left rudder and reverse on the engines was unsuccessful. The aircraft continued to track to the right of the centreline, departed the runway, and struck a hard-packed snow bank. There were no injuries to the two crew members. The aircraft was substantially damaged.

Other Factual Information

The aircraft, a Fairchild Metro SA227-AC operating as SpeedAir 905, departed St. John's Airport, Newfoundland and Labrador, at 0255 Atlantic standard time[1] on its first flight of the day, a scheduled courier flight to Goose Bay. On board was a crew of two and 2000 pounds of cargo. The flight continued uneventfully to Goose Bay, where it was vectored for a straight-in instrument landing system (ILS) approach to Runway 08. After intercepting the localizer, nine miles back from the airport, the crew completed pre-landing checks and, at 0452, contacted Goose Bay tower for landing clearance. The tower controller advised that the current runway surface condition (RSC) report for Runway 08 was, on a 120-foot centerline, 90 per cent snow covered one inch in depth, 10 per cent bare and dry. Runway lighting was set to maximum (strength six); at this setting, the runway visual range was reported to be greater than 6000 feet.

Just prior to the landing, the surface wind was reported at 340 degrees magnetic at 10 knots. The weather at Goose Bay at the time was as follows: visibility ½ mile in snow and drifting snow; vertical visibility 400 feet; temperature minus 13°C; dew point minus 15°C; and altimeter setting 29.30. Landing clearance was received and the crew flew an uneventful approach to Runway 08. At about 200 feet above the approach decision height, the crew acquired visual reference to the runway and completed the approach to touchdown at 0456:04.

Radar data show that the aircraft was on a stable approach and touched down near the correct reference speed of 111 knots. Shortly after the nosewheel tires contacted the ground, the aircraft started to veer to the right. The captain, the pilot flying, attempted to correct the veer with the application of left rudder. Despite a progressive application of full left rudder, the aircraft continued to track towards the right side of the runway. The captain then selected full reverse thrust; however, as the aircraft had just touched down and the Beta lights were not yet illuminated, reverse thrust was not available. The aircraft left the runway surface west of taxiway Charlie, about 3900 feet from the threshold. The right main gear caught in deeper snow and the aircraft spun rapidly to the right. Eleven seconds after touchdown, as the aircraft approached a snowbank, the copilot shut off the fuel to the engines by pulling the engine "stop and feather" controls fully aft. The aircraft then came to a sudden stop when it struck the hard-packed snow bank. The crew selected the electrical power off and evacuated the aircraft. After evacuating the aircraft, the copilot called company dispatch on his cellular phone and asked that they advise Goose Bay tower of their situation.

The emergency locator transmitter had not been activated by either impact forces or the crew. Because of the poor visibility on the airfield, the tower controller was not able to visually locate the aircraft. He had not heard the aircraft go around, and there was no target on his radar. He attempted to call the aircraft within moments of the accident. When there was no response, snow removal vehicles, which were operating on the airfield, were directed toward the runway to search for the aircraft. The aircraft and crew were located, and emergency response was initiated at 0500. The first emergency response vehicle was cleared onto the runway at 0505. The emergency response was delayed by four minutes because of the lack of communication from the aircraft to the tower prior to aircraft evacuation. Although no adverse consequences resulted from this delay, early response is considered critical in emergency situations.

The point at which the aircraft touched down could not be precisely determined. Airfield personnel reported that the aircraft's tracks in the snow began on the centreline, 1800 feet past the threshold of Runway 08. Three sets of tracks were left in the snow by the tricycle landing gear. The tracks were described as proceeding for

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[1] All times are Atlantic standard time (Coordinated Universal Time minus four hours) unless otherwise noted.

about 2000 feet in a fairly straight line from the runway centreline to the runway edge. The centre track, made by the nosewheel tires, was noted to be as large as the tracks made by the larger dual main wheel tires. The time between main wheel touchdown and impact with the snow bank was approximately 12 seconds.

The pilot and copilot were qualified for the flight in accordance with the Canadian Aviation Regulations and the air operator's training program. Both pilots were off duty for the preceding 52.5 hours and were adequately rested prior to the flight.

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The aircraft had no known deficiencies before the flight. It was being operated within the prescribed limits for weight and centre of gravity. Impact markings on the nosewheel centring cam showed that the nosewheel was deflected almost fully to the right when the nose gear struck the snow bank. The tires were found to be in good condition and there was no indication of skidding damage. The cockpit voice recorder was found to be in good condition and 30 minutes of audio information was recovered. The aircraft was not fitted with a flight data recorder and none was required by regulation.

The aircraft is equipped with a variable-authority nosewheel steering system. An electrically controlled hydraulic servo valve turns the nosewheel for steering. Nosewheel steering is armed and available during take-off and landing, but is not normally used above 60 knots. The nosewheel is free to caster unless it is engaged by the crew. Fault protection circuitry automatically deactivates the nosewheel steering if an electrical malfunction occurs, allowing the nosewheel to caster. During pre-departure checks at St. John's, the crew checked that the nosewheel steering was serviceable and operated normally. Also, as part of the pre-landing checks, the steering system was checked normal and armed while approaching Goose Bay. After the occurrence, the steering system was functionally tested in accordance with the aircraft's maintenance manual. The systems were verified and the steering operated normally. The steering amplifier and fault protection unit was removed and bench tested. No fault was found that would have resulted in a steering malfunction. There was no indication of recent previous steering malfunctions on this aircraft.

Since direct nosewheel steering is too sensitive at high speeds, and aerodynamic forces are available to provide directional control in that regime, it is common design practice to permit an aircraft nosewheel to caster freely during the high speed portion of a landing. As there were no defects found with the nosewheel steering system, the nosewheel should have been able to caster immediately following touchdown. While castering, ground forces cause the nosewheel to swivel about its steering axis. Normally, the geometry is such that when the wheel is disturbed, the castering forces will act in a stable (positive) manner and restore the wheel to its trail position. In some cases, however, the geometry of the castering mechanism may allow disturbances to the nosewheel to be amplified, and the wheel will be forced hard to one side against the steering stops (negative castering). A build-up of snow ahead of the wheel during travel across a snow-covered surface can contribute to negative castering. Merlin II aircraft have been prone to negative castering; however, Merlin III and Metro versions have an improved geometry which is more stable. An analysis of the geometry of the Merlin III and Metro nosewheel design by the TSB Engineering Branch showed that negative castering could still

occur, though under more severe adverse conditions. The accident crew members were not aware of the negative castering phenomenon. The TSB is aware of only one negative castering occurrence on the Merlin III.

Negative castering is not mentioned in any of the aircraft publications or the operator's training material. The only emergency procedures for loss of directional control in the on-board emergency checklist are titled *Nosewheel Steering Fail*. Section D, titled *In flight gear down landing*, states that in the event of a failure, the nosewheel steering system must be switched off prior to landing, and, during landing, directional control of the

aircraft must be maintained using the rudder, differential power, and brakes. The crew did not have an indication of nosewheel steering failure prior to landing, and the nosewheel steering failure light was not noticed during the approach or the landing.

Analysis

Radar data showed that the approach to landing was stable and, as evidenced by the wheel tracks, the touchdown was on the centreline. The crew had visual reference with the runway 200 feet above decision height, and it is not likely that the aircraft was misaligned or that pilot technique during the approach or prior to the touchdown contributed to the occurrence. Although the wind was blowing across the runway from left to right at 10 knots, it was within normal landing parameters and would not, of itself, have caused the aircraft to veer suddenly and uncontrollably to the right.

The steering was armed but not engaged, and the nosewheel was free to caster. The steering system was functionally checked after the occurrence and no fault was found. There had been no indication of recent previous steering malfunctions on this aircraft, and it is considered unlikely that a malfunction in the steering system contributed to the hard-over. Had the nosewheel steering been inadvertently engaged during the landing, the nosewheel steering system should have provided correction when the captain applied progressive left rudder.

It is more likely that snow on the runway built up ahead of the nosewheel, contributing to the conditions necessary for negative castering. The combination of crosswind and runway contamination acted to disturb the nosewheel and trigger the onset of negative castering. Once the nosewheel was disturbed, it would be forced to a hard-over position, in this instance fully to the right. The captain attempted to correct the sudden veer with rudder and tried to slow the aircraft with reverse thrust. The rudder may have lessened the amount of veer, but control was not adequate to keep the aircraft on the runway. As reverse thrust mode was not yet available, its application had no effect on steering or slowing the aircraft. The crew had little opportunity to consider or attempt other corrective actions. If the nosewheel was castering, selecting the nosewheel steering off would have had no effect once the wheel had gone to the hard-over position.

Negative castering is not identified in the aircraft's abnormal procedures section, and the phenomenon is not well known in the aviation community. As the crew could not identify the cause of the veer, and had little opportunity for troubleshooting, other corrective actions were not attempted.

The following TSB Engineering Branch reports were completed:

LP 013/2002 - *CVR/Radar Data Analysis*
LP 052/2002 - *Negative Nosewheel Castering Evaluation*

Findings as to Cause and Contributing Factors

1. Aircraft directional control was lost, likely because of negative castering of the nosewheel when snow piled up in front of the nosewheel assembly.

Findings as to Risk

1. The crew members were not aware of negative castering; the aircraft flight manual and emergency checklists do not address negative castering.

2. The emergency response to the occurrence was delayed by four minutes because of the lack of communication from the aircraft to the tower.

Safety Action

In March 1990, the TSB forwarded a Safety Advisory Letter to Transport Canada concerning the loss of directional control in Swearingen Merlin IIA and IIB aircraft due to negative castering of the nosewheel on landing. The letter suggested that operators be informed of negative castering and that changes be made to flight and maintenance manuals to ensure that the information is not forgotten over time. In March of 1994, the TSB forwarded a supplementary to this letter after a Merlin III experienced a loss of directional control while landing on a snow-covered gravel runway (A93C0187). In response to the letters, TC published an article in the Aviation Safety Letter, issue 4/94. The article mentioned negative castering, but its primary focus was on poor runway conditions. The article may have temporarily increased the level of knowledge of negative castering, but did little to alleviate the risks associated with the event.

To date, the TSB is aware of no substantive changes to training materials, flight manuals or emergency procedures which would serve to permanently improve crew knowledge of negative castering, and their ability to recognize and respond to negative caster events. Therefore, on 04 April 2003, the TSB forwarded to Transport Canada a third Aviation Safety Advisory suggesting that Transport Canada consider more permanent and systemic action to reduce the risks associated with negative castering events.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 April 2003.