# Aviation Investigation Final Report

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| **Location:** | Salt Lake City, Utah | **Accident Number:** | WPR11LA058 |
| **Date & Time:** | November 23, 2010, 22:20 Local | **Registration:** | N614SK |
| **Aircraft:** | BOMBARDIER INC CL-600-2C10 | **Aircraft Damage:** | Substantial |
| **Defining Event:** | Ground handling event | **Injuries:** | 69 None |
| **Flight Conducted Under:** | Part 121: Air carrier - Scheduled | | |

## Analysis

The airplane was operating 2 hours behind schedule and had been dispatched with its auxiliary power unit (APU) inoperative, a condition that was permissible based on the approved Minimum Equipment List. The ramp area was covered in snow and ice, and it was snowing during aircraft loading and the subsequent pushback attempt. The captain started both engines while the airplane was at the gate, utilizing an external air-start cart in lieu of the APU. The captain stated that he started both engines due to a concern that, by starting one engine only, he would encounter control problems taxiing in the slippery conditions. He recognized that he could also have attempted to start the second engine in the alleyway after pushback using a cross-bleed engine start, but was concerned that attempting such a start would require increased engine thrust on the operating engine and could be disruptive to ground personnel and other traffic within the alleyway.

During pushback, the tug was unable to gain enough traction to move the airplane and was subsequently replaced with a larger tug. The larger tug was able to push back the airplane; however, a short time later the thrust from the airplane's engines, which were running at idle, exceeded the traction available to the tug. The captain, seated in the left seat, experienced a sensation of unusual movement as the airplane began to overpower the tug, and he asked the tug driver if the driver still had control of the airplane. The tug driver confirmed that he had control; however, the airplane subsequently moved forward while still attached to the tug, which rotated to the right striking the airplane's fuselage.

According to ground personnel and flight crew guidance, if the ramp surface conditions were such that adequate traction was not available, engine start should have been delayed until the

pushback was complete. However, an engine start was required prior to pushback due to the inoperative APU. No guidance existed for either the flight or ground crew regarding pushback procedures in low traction ramp conditions with an inoperative APU.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The tug driver's loss of airplane control during pushback due to a loss of traction in slippery conditions on the ramp. Contributing to the accident was the ground crews' and airline operators' inadequate guidance with regard to pushback procedures during low ground traction conditions with an inoperative airplane auxiliary power unit.

### Findings

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| **Aircraft** | (general) - Inoperative |
| **Personnel issues** | (general) - Ground crew |
| **Organizational issues** | Adequacy of policy/proc - Operator |
| **Organizational issues** | Adequacy of policy/proc - Not specified |
| **Environmental issues** | Snow/slush/ice covered surface - Effect on equipment |

# Factual Information

## History of Flight

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| **Prior to flight** | Sys/Comp malf/fail (non-power) |
| **Pushback/towing** | Ground handling event (Defining event) |

HISTORY OF FLIGHT

On November 23, 2010, about 2220 mountain standard time, a Bombardier CL-600-2C10 (CRJ), N614SK, operated by SkyWest Airlines as Delta Connection flight 4543, collided with a tow tractor during pushback from gate B4 at Salt Lake City International Airport (SLC), Salt Lake City, Utah. The 2 flight deck crewmembers, 2 flight attendants, 65 passengers, and ground handling crew were not injured. The airplane sustained substantial damage to the lower fuselage skin and multiple belly stringers. The scheduled passenger flight was operating on an instrument flight plan and was destined for Will Rogers World Airport (OKC), Oklahoma City, Oklahoma, under the provisions of 14 Code of Federal Regulations Part 121. Night instrument meteorological conditions prevailed. The flight was delayed prior to the accident, with a scheduled departure time of 2000.

SkyWest Airlines is a regional airline headquartered in St. George, Utah. The airline serves as a feeder airline and operates under contract with various major carriers. The accident flight was performed under a code sharing agreement with Delta Air Lines, Inc. Ground handling duties at the time of the accident were performed by agents from Delta Air Lines, Inc. The airplane was dispatched with the auxiliary power unit (APU) inoperative, a condition which is permissible based on the airplane's Minimum Equipment List (MEL), and which requires that one or both engines be started utilizing an external air-start cart or a precharged air bottle.

The airplane load agent, who was responsible for driving the tow tractor, stated that snow was falling during the loading and pushback sequence. He reported that during loading he observed a member of the flight crew performing an external preflight inspection.

Once the airplane had been loaded, he began to prepare for pushback. He was seated in the tow tractor, which was configured as a pushback tug and connected to the airplane's nose wheel utilizing a tow bar. He was in communication with the flight crew via the interphone, and stated that the crew could see him from their position on the flight deck. The captain requested an, "air-start" at the gate, and reported that he was going to start both engines. The engines were then started and the captain reported that the brakes were released and they were clear to commence the pushback. The driver then began the process of pushing the airplane back, but the wheels of the tug slipped and the airplane would not move. He subsequently informed the flight crew, and he decided to use a larger tug. With the larger tug attached, he began the pushback. The airplane subsequently started moving, and they began

to back out of the gate area towards the alleyway. He was about to begin the turn into the alleyway, when the airplane started to skid to the left in the direction of the turn. He reported that the airplane then began to move forward, towards the tug, pushing it to the right side of the airplane. The driver stated that about this time, the captain asked if the airplane was pushing the tug, to which he responded yes. The airplane continued to move forward, subsequently overtaking the tug, which remained connected to the airplane's nose wheel. He further reported that the tug struck the belly of the airplane about the same time as tow bar severed at the nose wheel connection.

The tug driver reported that two wing-walkers were present at the time of the accident, and that neither tug was equipped with snow chains or traction devices.

The captain recounted similar observations regarding the initial pushback attempt. He became concerned that disconnecting the tug with both engines running could cause the airplane to move forward in the slippery conditions. He considered shutting down one or both of the engines; however, when he attempted to communicate his concerns with the driver, he had already departed to get the larger tug. By this time, the air-start equipment had also been removed from the gate area. The airplane appeared to remain firmly in position at the gate, and as such, he decided to keep both engines running.

The driver returned with a larger tow tug, and the airplane was successfully pushed back from the gate. Shortly thereafter, the captain experienced a turning and slipping sensation. He asked the tug driver if he still had control of the airplane, to which he replied in the affirmative. He then observed the tug rotate to the right and felt a collision. He reported that although he did not believe the airplane was moving forward, the events transpired so quickly that it was possible he may have missed any forward motion. As such, he could not definitively confirm if the tug struck the airplane, or if the airplane struck the tug.

With regard to starting both engines instead of one in lieu of a functioning APU, the captain stated that he made a judgment call based on a concern that if he started one engine only, he would encounter control problems taxing in the slippery conditions. He reported that he could also have attempted to start the second engine in the alleyway after pushback using a cross-bleed start. However, he was concerned that attempting such a start would require increasing the power to the running engine and could be disruptive to ground personnel and other traffic within the alleyway.

With regard to weather, the captain stated that although snow was falling at the time, the ramp area at the gate was plowed and mostly clear, and that the alleyway was contaminated with snow and ice. His view was not obscured by precipitation during the maneuver, and he could see the tug.

Examination of a photograph taken following the accident revealed that the airplane's nose gear had become canted to the right over-steer limits, with the tow bar bracket remaining partially attached to the left side of the wheel by the axle engagement pins. The bracket

separated from the tow bar at its shank, which remained within the tow bar collar. The tow bar remained attached to the tug, which had come to rest impinged against the right forward fuselage, and opposite the direction of travel. Tire-shaped snow tracks were observed in the snow behind the nose wheel, the tracks continued in a sweeping arc aft towards the left side of the airplane. No snow disruption was present forward of the nose wheel.

## METEOROLOGICAL INFORMATION

A special automated surface weather observation for SLC was issued at 2222. It indicated winds from 020 degrees at 6 knots; 2 miles visibility, with light snow and mist, a broken cloud ceiling at 1,600 feet, scattered clouds at 700 feet and overcast at 6,000 feet; temperature minus 7 degrees C; dew point minus 9 degrees C; and an altimeter setting of 29.81 inches of mercury.

## FLIGHT RECORDERS

The airplane was equipped with both a Flight Data Recorder (FDR), and a Cockpit Voice Recorder (CVR). Both units were sent to the NTSB Office of Research and Engineering for data extraction. Examination of the CVR revealed that the unit was not de-energized subsequent to the collision, and as such, the accident sequence had become overwritten.

The FDR recorded about 77 hours of data, including the accident sequence. The data revealed that both engines were started about 2158 and powered to an N1 (Fan rpm) speed of 25% rpm while the airplane remained on a heading of 142 degrees magnetic. At 2220, the heading decreased until it reached 57 degrees, 45 seconds later, with a coincident jump in lateral and longitudinal acceleration of 0.07 and -0.08 g, respectively. The brake pedals were not applied until about 2 seconds after the acceleration event.

## ADDITIONAL INFORMATION

SkyWest CRJ Standard Operating Procedures (SOP), in part, required the following prior to commencing the pushback:

"When ramp surface conditions would prevent adequate traction for ground equipment, engine start will be delayed until pushback is complete, and the pushback crew is clear of the aircraft. The pushback operator is responsible to notify the captain accordingly."

The corresponding SkyWest "Below-Wing Stations Operating Manual" made the following reference with regard to pushback/dispatch procedures with the tow bar and tow unit:

"WARNING - WHEN RAMP SURFACE CONDITIONS PREVENT ADEQUATE PUSHBACK UNIT TRACTION, ENGINE START MUST BE DELAYED UNTIL PUSHBACK IS COMPLETE. THE PUSHBACK OPERATOR IS RESPONSIBLE TO NOTIFY THE PIC ACCORDINGLY."

Neither the SOP nor the Below-Wing Operations Manual provided guidance for pushback procedures with an inoperative APU during low traction ramp conditions.

Subsequent to this accident, SkyWest issued a Ground Operations Bulletin, and Delta issued an Immediate Action Bulletin requiring that when ramp surface conditions prevent adequate pushback unit traction, only one engine may be started prior to pushing back a regional jet aircraft.

## Pilot Information

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| **Certificate:** | Airline transport; Commercial | **Age:** | 48,Male |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | |
| **Instrument Rating(s):** | Airplane | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Airplane multi-engine; Airplane single-engine | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 1 With waivers/limitations | **Last FAA Medical Exam:** | July 19, 2010 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | July 25, 2010 |
| **Flight Time:** | 10066 hours (Total, all aircraft), 6846 hours (Total, this make and model), 5135 hours (Pilot In Command, all aircraft) | | |

## Co-pilot Information

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| **Certificate:** | Commercial | **Age:** | 31,Male |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Right |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | |
| **Instrument Rating(s):** | Airplane | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Airplane single-engine | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 1 Without waivers/limitations | **Last FAA Medical Exam:** | March 26, 2010 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | January 7, 2009 |
| **Flight Time:** | 3317 hours (Total, all aircraft), 2135 hours (Total, this make and model) | | |

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | BOMBARDIER INC | **Registration:** | N614SK |
| **Model/Series:** | CL-600-2C10 | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | | **Amateur Built:** | |
| **Airworthiness Certificate:** | Transport | **Serial Number:** | 10051 |
| **Landing Gear Type:** | Retractable - Tricycle | **Seats:** | 69 |
| **Date/Type of Last Inspection:** | November 22, 2010 Continuous airworthiness | **Certified Max Gross Wt.:** | 75000 lbs |
| **Time Since Last Inspection:** | | **Engines:** | 2 Turbo fan |
| **Airframe Total Time:** | 20574 Hrs as of last inspection | **Engine Manufacturer:** | General Electric |
| **ELT:** | C126 installed, not activated | **Engine Model/Series:** | CF34-8C5B1 |
| **Registered Owner:** | ATLANTIC SOUTHEAST AIRLINES INC | **Rated Power:** | 9140 Lbs thrust |
| **Operator:** | SKYWEST AIRLINES INC | **Operating Certificate(s) Held:** | Flag carrier (121) |
| **Operator Does Business As:** | Delta Connection | **Operator Designator Code:** | SWIA |

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Instrument (IMC) | **Condition of Light:** | Night |
| **Observation Facility, Elevation:** | SLC,4227 ft msl | **Distance from Accident Site:** | 0 Nautical Miles |
| **Observation Time:** | 22:22 Local | **Direction from Accident Site:** | |
| **Lowest Cloud Condition:** | Scattered / 700 ft AGL | **Visibility** | 2 miles |
| **Lowest Ceiling:** | Broken / 1600 ft AGL | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 5 knots / None | **Turbulence Type Forecast/Actual:** | / |
| **Wind Direction:** | 10° | **Turbulence Severity Forecast/Actual:** | / |
| **Altimeter Setting:** | 29.8 inches Hg | **Temperature/Dew Point:** | -7°C / -9°C |
| **Precipitation and Obscuration:** | N/A - None - Mist | | |
| **Departure Point:** | Salt Lake City, UT (SLC ) | **Type of Flight Plan Filed:** | IFR |
| **Destination:** | Oklahoma City, OK (OKC ) | **Type of Clearance:** | None |
| **Departure Time:** | 21:50 Local | **Type of Airspace:** | |

## Airport Information

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| **Airport:** | Salt Lake City SLC | **Runway Surface Type:** | |
| **Airport Elevation:** | 4227 ft msl | **Runway Surface Condition:** | |
| **Runway Used:** | | **IFR Approach:** | None |
| **Runway Length/Width:** | | **VFR Approach/Landing:** | None |

## Wreckage and Impact Information

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| **Crew Injuries:** | 69 None | **Aircraft Damage:** | Substantial |
| **Passenger Injuries:** | | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 69 None | **Latitude, Longitude:** | 40.788333,-111.977775(est) |

## Administrative Information

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| **Investigator In Charge (IIC):** | Simpson, Eliott |
| **Additional Participating Persons:** | Skeeter Gehring; Federal Aviation Administration FSDO; Salt Lake City, UT<br>Michael Eisenstat; SkyWest Airlines; St. George, UT<br>Shannon M Masters; Delta Airlines; Atlanta, GA |
| **Original Publish Date:** | March 8, 2012 |
| **Last Revision Date:** | |
| **Investigation Class:** | Class |
| **Note:** | |
| **Investigation Docket:** | https://data.ntsb.gov/Docket?ProjectID=77874 |