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

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A24W0038

AFT FUSELAGE STRIKE AND HARD LANDING

WestJet Encore Ltd.
Bombardier Inc. DHC-8-402, C-GJWE
Calgary International Airport (CYYC), Alberta
13 April 2024

History of the flight

On 13 April 2024, the WestJet Encore Ltd. Bombardier Inc.[1] DHC-8-402 aircraft (registration C-GJWE, serial number 4460) was operating as flight WEN3136 from Fort McMurray Airport (CYMM), Alberta, to Calgary International Airport (CYYC), Alberta, with 4 crew members and 78 passengers on board.

The first officer (FO) was the pilot flying and the captain was the pilot monitoring. The flight crew had initially planned and set up for landing on Runway 17L, but just before the descent, they were informed that the active runway had changed to Runway 35R. They briefed the area navigation (required navigation performance) (RNAV [RNP]) Y approach for Runway 35R before the descent, which began at 1438 Mountain Daylight Time[2] from 24 000 feet above sea level (ASL). Data from

[1] The current type certificate holder is De Havilland Aircraft of Canada Limited.

[2] All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

the digital flight data recorder (DFDR) showed that the approach was typical, with light turbulence in the descent. At approximately 6100 feet ASL, the landing gear was extended, flaps were set to 15°, and the propellers were set to 1020 rpm for landing.

Based on the aircraft landing weight of 58 738 pounds, the approach speed was established at 132 knots indicated airspeed.[3] The surface winds were reported to be from 330° true (T) at 10 knots, gusting to 20 knots. No additive for the gust was made to the approach speed.

The autopilot was turned off at 500 feet above ground level (AGL) and the remainder of the approach was hand flown by the FO. From 500 feet AGL to touchdown, the power levers were adjusted up and down 12 times between 22% torque and 4% torque (Appendix A). Once below 350 feet AGL on approach, the aircraft's descent path varied above and below the 3° approach descent path. During this time, the captain made 3 calls to the FO to increase power. The FO responded by increasing power each time; however, the last increase in power was quickly followed by a reduction in power to 4% torque.

The aircraft crossed the Runway 35R threshold at 65 feet AGL. Over the next 6 seconds, the aircraft experienced a performance-degrading wind gust with an approximate speed of 8 knots. The FO began to increase the nose-up attitude to start the flare, slowing the aircraft to 120 knots calibrated airspeed. Two seconds before touchdown, the pitch attitude increased from 5° to 8.3° and the power levers were advanced. At touchdown, the power increased to 8% torque, and then up to 18% torque after touchdown.

At 1452:26, the aft fuselage of the aircraft contacted the runway approximately 1070 feet beyond the threshold, illuminating the "TOUCHED RUNWAY"[4] warning light in the caution and warning light panel. The captain taxied to the gate. While the passengers deplaned normally, the flight crew discussed the landing and called company maintenance. There were no injuries. The emergency locator transmitter did not activate.

Aircraft damage

The aircraft sustained substantial damage to the lower aft fuselage structure that consisted of deformed frames and stringers and perforated belly skins. The tail strike switch also broke off at impact (Figure 1).

The left-hand engine nacelle inboard skins were found wrinkled during the inspection. The investigation could not determine if this damage was sustained during this occurrence.

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[3] WestJet Encore Ltd. standard operating procedures indicate an approach speed that is based on the manufacturer's landing reference speed plus 10 knots.

[4] The "TOUCHED RUNWAY" warning light informs the flight crew of contact made by the lower aft fuselage structure with the runway. Its illumination requires an inspection of the aircraft by qualified maintenance personnel before further flight.

Figure 1. Lower aft fuselage damage and broken off tail strike switch on the occurrence aircraft (Source: Third party [with permission], with TSB annotations)

Flight crew information

The flight crew had been paired together for 4 days and the occurrence flight was the final flight of their pairing schedule. The investigation determined that the flight crew held the appropriate licences for the flight in accordance with existing regulations.

The captain held a valid airline transport pilot licence – aeroplane. At the time of the occurrence, he had 3509 hours total flight time, including 1981 hours on the DHC-8-400 series aircraft. The captain had been employed by WestJet Encore Ltd. since 2019.

The FO held a valid commercial pilot licence – aeroplane. At the time of the occurrence, the FO had 1390 hours total flight time, including 184 hours on the DHC-8-400 series aircraft. The FO had been employed by WestJet Encore Ltd. since November 2023. He had completed his initial training on the graphical and full flight simulators in December 2023 and his line indoctrination training in February 2024. Since then, the FO had flown as a flight crew member on 84 flights, including the occurrence flight.

The occurrence flight was the 1st flight of the day for the flight crew. Based on a review of the flight crew's work and rest schedule, there was no indication that their performance was degraded by fatigue.

Weather information

The flight crew obtained weather information from NAV CANADA's graphic area forecasts, aerodrome forecasts, and the aerodrome routine meteorological report from CYYC that reported the following at 1500:

- Winds from 330°T at 12 knots, gusting at 20 knots
- Wind direction variable from 260°T to 350°T
- Visibility of 40 statute miles
- Few clouds at 11 000 feet, broken ceiling at 20 000 feet
- Temperature 17 °C, dew point −8 °C
- Altimeter setting 29.78 inches of mercury

Aircraft information

The DHC-8-402 is a twin-engine (Pratt & Whitney PW150A) turboprop regional airliner capable of seating 78 passengers. The aircraft has a maximum take-off weight of 65 200 pounds and a maximum landing weight of 62 000 pounds. The aircraft was manufactured in 2013 and had 20 941 total air frame hours and 19 076 cycles on it at the time of the occurrence.

At the time of the occurrence, the aircraft weight and centre of gravity were within the prescribed limits and there were no known defects outstanding. There was no indication that a component or system malfunction played a role in this occurrence.

Flight recorders

The occurrence aircraft was equipped with a cockpit voice recorder (CVR) capable of recording 120 minutes of audio and a DFDR that recorded various parameters, including the weight-on-wheels indication, the "TOUCHED RUNWAY" light indication, and vertical acceleration (N_Z). The aircraft was also equipped with a flight management system computer that provided centralized control of the aircraft's navigation sensors, computer-based flight planning, and fuel management.

The CVR and DFDR were forwarded to the TSB Engineering Laboratory in Ottawa, Ontario, for data download. The CVR provided an audio recording of the communication between the captain and FO before and during the occurrence.

The DFDR revealed an N_Z of 2.31*g* and a lateral acceleration of 0.54*g* on contact with the runway, as well as other parameters for the occurrence flight.

Hard landing

The aircraft maintenance manual specifies required inspection procedures to be carried out after a hard landing before the aircraft can be returned to service. Hard landings are recorded by the DFDR in terms of N_Z. Inspections are categorized as level 1 or level 2 based on the aircraft landing weight. For aircraft with a landing weight between 58 000 and 62 000 pounds with an N_Z between

2.20 and 2.39*g*, a level 1 inspection is required.[5] Following the occurrence, a level 1 inspection was performed.

Pitch awareness

In approximately 2003, after a series of DHC-8 aft fuselage strike incidents in which the pilots reacted instinctively by quickly increasing the pitch to stop an excessive rate of descent, the aircraft manufacturer (Bombardier Inc.) produced a training video.[6] The video stresses the importance of monitoring the aircraft's pitch and managing its energy by controlling an excessive rate of descent by applying engine power rather than increasing pitch near the ground.

When the main landing gear oleos are compressed during a hard landing, the fuselage of the DHC-8-400 touches the ground at approximately 7° pitch.

In 2008, even though the video had been out for 5 years, aft fuselage strikes were still occurring. In response, the manufacturer released a service letter on 11 September 2008.[7] The letter was intended solely for DHC-8-400 operators and reiterated the importance of pitch awareness during the flare and touchdown. The letter recommended including standard 5° and 6° pitch awareness calls in the procedures and managing the rate of descent below 200 feet AGL with the power levers. The service letter also referred to the training video and suggested that operators offer initial and recurrent training on pitch awareness.

In addition to this occurrence, there have been 13 other aft fuselage strike occurrences reported to the TSB on the DHC-8 aircraft since 2002: 1 for the 100 series, 6 for the 300 series, and 6 for the 400 series.[8] In these occurrences, the pitch had exceeded the limits stated in the aircraft operating manual.

WestJet Encore Ltd. procedures and training

WestJet Encore Ltd.'s aircraft operating manual for the DHC-8-400[9] includes the following pitch attitude procedures and standard callouts in its normal procedures:

- At a pitch attitude approaching 5°, the pilot monitoring is to call "5 degrees" and the pilot flying is to state "5 degrees."
- At a pitch attitude approaching 6°, the pilot monitoring is to call "6 degrees" and the pilot flying is to state "Correcting" and adjust the pitch attitude to 5° or below.

In this occurrence, the pitch increase took less than 2 seconds to go from 5° to 8.3° at touchdown. During this time, there were no standard pitch call outs for 5° and 6° pitch attitudes.

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[5] De Havilland Aircraft of Canada Limited., *De Havilland Dash 8 Series 400 Aircraft Maintenance Manual*, Temporary Revision (14 September 2023), Task 05-50-06-210-801: Inspection After a Hard Landing.

[6] De Havilland Inc. (Bombardier Inc.), "Dash 8-Q400 Pitch Awareness" [video] (2003).

[7] Bombardier Inc., Service Letter DH8-400-SL-00-020: Q400 Pitch Awareness Training (11 September 2008).

[8] TSB aft fuselage strike investigations: A24A0038 (ongoing), A22C0093, A22C0094, A20Q0013, A16Q0002, A14W0079, A13O0098, A12Q0161, A12O0156, A09O0073, A08W0229, A05Q0054, and A02O0317.

[9] WestJet Encore Ltd., *Aircraft Operating Manual - DHC-8-400*, Revision 027 (01 June 2023), section 3.1.1: Standard Callouts, p. 3-5.

WestJet Encore Ltd.'s classroom, graphical flight simulator, and full flight simulator training was reviewed, and it was determined it covered the information in the manufacturer's service letter and video.

TSB laboratory reports

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

- LP072/2024 – Flight Data Recovery
- LP073/2024 – CVR Audio Recovery

Safety action taken

Following the occurrence, the captain and FO completed additional simulator training reinforcing pitch awareness, among other elements, before they were assigned any further flying duties. WestJet Encore Ltd. also:

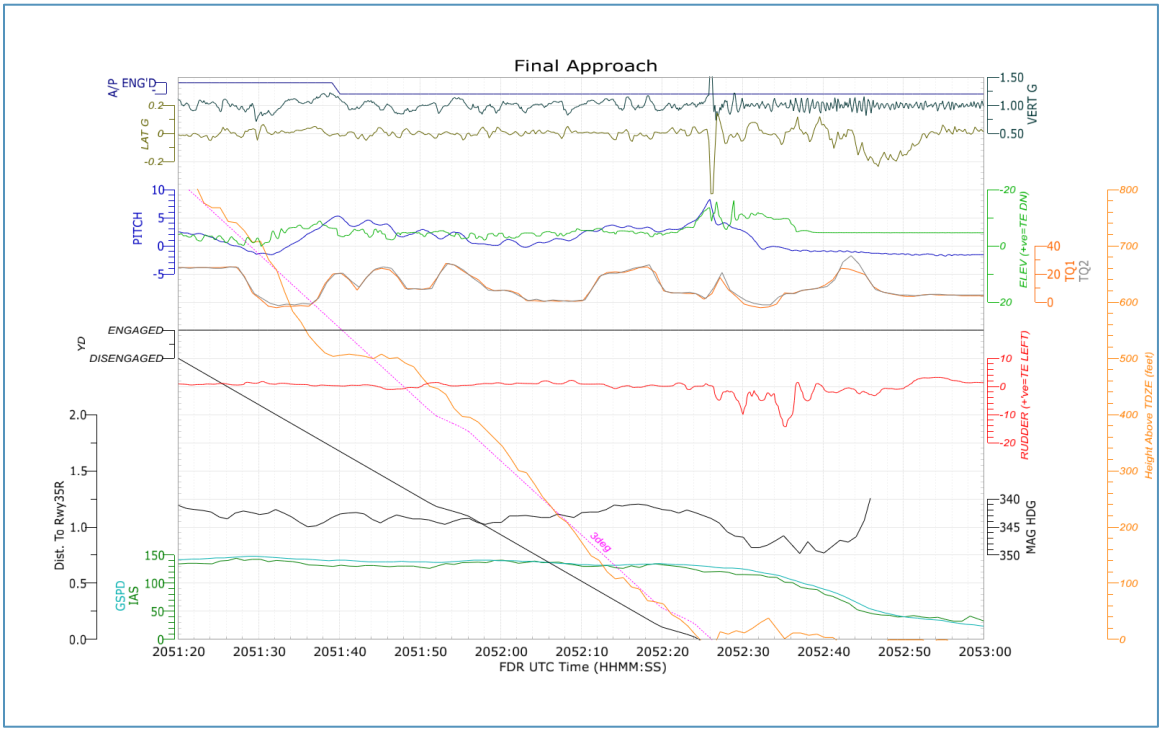
- communicated awareness of pitch attitudes, tail strikes, and hard landings to its flight crews in a number of its internal communication products.
- amended its pilot training curriculum and guidance material to include more emphasis on pitch awareness, landing technique, pilot monitoring call outs, and power management in the flare.
- increased the use of flap 35 landing configuration during initial line indoctrination training, and initial and recurrent simulator training.

Safety messages

Flight crews are reminded that in the later stages of an approach, descent rate is to be arrested by adding power, especially when operating an aircraft that has a history of aft fuselage strikes, as is the case with the DHC-8-400 series.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 14 November 2024. It was officially released on 26 November 2024.

Appendix A – Parameters extracted from the occurrence aircraft's digital flight data recorder



Source: TSB

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