Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A04O0237

FLIGHT CONTROL DIFFICULTIES

JAZZ AIR INC.
DE HAVILLAND DHC-8-102 C-FGRP
KINGSTON, ONTARIO
02 SEPTEMBER 2004

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Summary

The de Havilland DHC-8 aircraft (registration C-FGRP, serial number 207) was being operated by Jazz Air Inc. as flight number JZA7841 from Kingston, Ontario, to Toronto/Lester B. Pearson International Airport, Ontario. The aircraft departed Kingston at 1403 eastern standard time with the first officer, in the right seat, designated as the pilot flying.

During the initial climb following take-off, the first officer noted that abnormal forward pressure on the control column was required to keep the aircraft from pitching nose up. To counter the pitch-up, he trimmed the aircraft nose down. Thirty seconds after becoming airborne, the aircraft was 350 feet above ground level (approximately 700 feet above sea level (asl)) and the first officer had applied full nose-down trim. The amount of forward pressure on the control column continued to increase as the aircraft accelerated, and the first officer notified the captain of the control difficulties and requested his assistance in holding the control column forward. As the aircraft climbed, the captain declared an emergency, indicating that they were experiencing control difficulties and that the aircraft may have to land at Trenton, Ontario. The flight crew levelled the aircraft at 4000 feet asl and pulled the elevator pitch disconnect handle, isolating the left and right elevators. The captain's elevator control functioned normally after the disconnect, and he decided to continue the flight. The flight crew conducted a flapless landing at Toronto without further incident.

Ce rapport est également disponible en français.

Other Factual Information

History of the Flight

The flight crew members had spent the night in Kingston and were waiting at the airport when the aircraft arrived. This was their first flight of the day, although the aircraft had already flown this day on four prior flights by three different flight crews. The captain conferred with the incoming captain, while the first officer conducted the preflight inspection of the aircraft. There were no reported flight control anomalies on the previous flight, and there was nothing out of the ordinary noted by the first officer during his inspection.

The turn-around time in Kingston was approximately 15 minutes. During the take-off run, at about 1430 eastern daylight time,[1] the controls were lighter than normal, and at rotation, almost no nose-up force was required. As the aircraft became airborne and accelerated, increasing forward pressure on the control column was required to maintain the proper climb attitude, even with full nose-down trim.

The flight crew members assessed that there was a pitch control anomaly, not a jammed elevator control or load shift. They were still able to control the aircraft and maintain the correct climb attitude and so they continued with normal climb procedures. The aircraft was levelled off at the assigned altitude of 4000 feet asl, the flaps were retracted, and the aircraft was allowed to accelerate. The crew reviewed the Air Canada Jazz *Quick Reference Handbook* (QRH) and the Abnormal/Emergency Procedures section of the Dash 8 Standard Operating Procedures (SOP). Although they had previously assessed that the elevator control was not jammed, they decided that the pitch control jam procedure was the most appropriate for their circumstance. The aircraft was slowed from 185 to 150 knots indicated airspeed (KIAS), the maximum speed for a jammed pitch control. The pitch disconnect was pulled, and the left-side elevator controls became free and functioned normally. The captain assumed control of the aircraft and climbed to 12 000 feet asl in the vicinity of Trenton and decided to continue to Toronto.

When the aircraft was inspected after landing, half of one of the balance weights from the right-side elevator spring tab, and the two nuts that secure it were missing. The two bolts had migrated out of the remaining half weight and jammed on the top surface of the elevator, holding the elevator spring tab in the trailing-edge-down position.

Pitch Control System

The DHC-8 pitch control system consists of two elevator control cable circuits, each operating an independently mounted, spring tab–assisted elevator. Each elevator has a spring tab at the inboard end and a trim tab at the outboard end. The left elevator is actuated by the captain's control column through the left cable control circuit and the left elevator spring tab system. The right elevator is actuated by the first officer's control column through similar components. The two control columns are normally interconnected to provide simultaneous movement of both

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

elevators, but the control columns can be disconnected by a pitch disconnect system if one of the control cable circuits jams. This frees the unjammed circuit and allows it to operate through its normal range.

Elevator Spring Tab Operation

The spring tab system for each elevator is designed to provide aerodynamic assistance to elevator movement. There are two mass balances extending forward of each spring tab leading edge (see Figure 1). Each mass balance assembly consists of two weights bolted together and secured to the arm with two bolts.

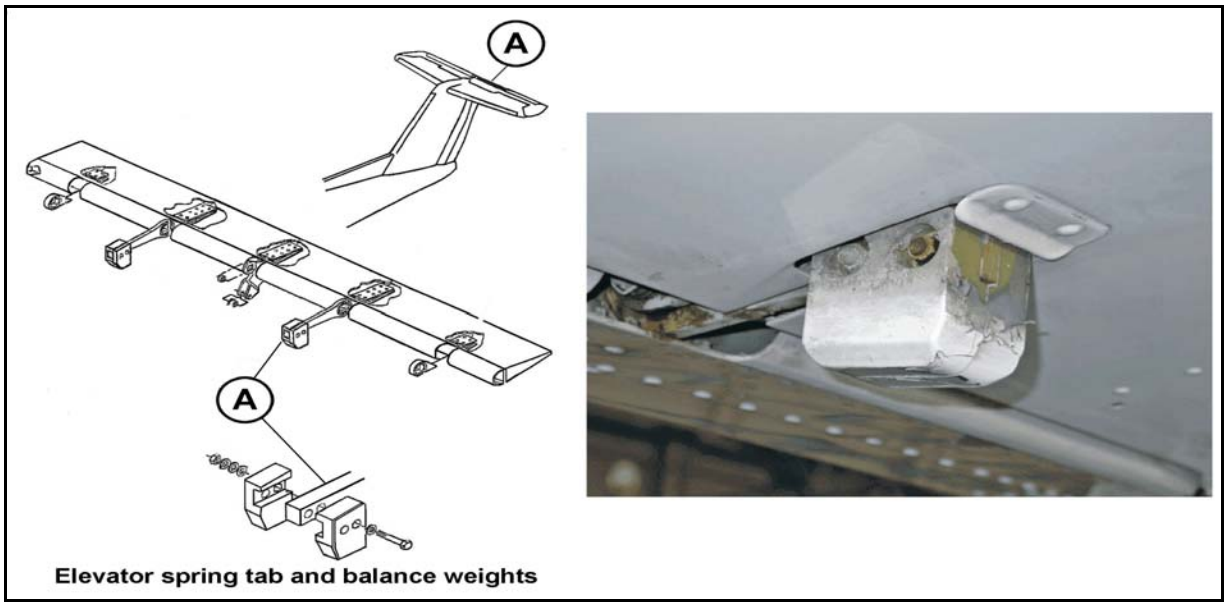

Figure 1. Elevator spring tab and balance weights

When the elevators are actuated, the control column movements go directly to the spring tab and then to the elevator through the torque shaft (see Figure 2, item 3). With the airplane on the ground and no aerodynamic load, the stiffness of the torque shaft overcomes the weight of the elevator, causing it to move with the control column. The geometry of the actuating hardware causes the elevator to move in the opposite direction to the spring tab. Maximum spring tab deflection is limited by the crank stops (Figure 2, item 8), after which the elevators are moved directly by the control column. Maximum elevator deflection is limited by the lever stops (Figure 2, item 12).

The flight data recorder showed that the two elevators were moving approximately in sync with each other until the aircraft was accelerating on the take-off run. The maximum differential in elevator deflection was reached when the airspeed was at approximately 120 KIAS; the right elevator was approximately 12° trailing edge up and the left elevator was approximately 8° trailing edge down. According to calculations completed after the occurrence, at 185 KIAS, the stress on the tail was close to its structural limit, and a specific, one-time maintenance inspection was designed to look for additional damage.

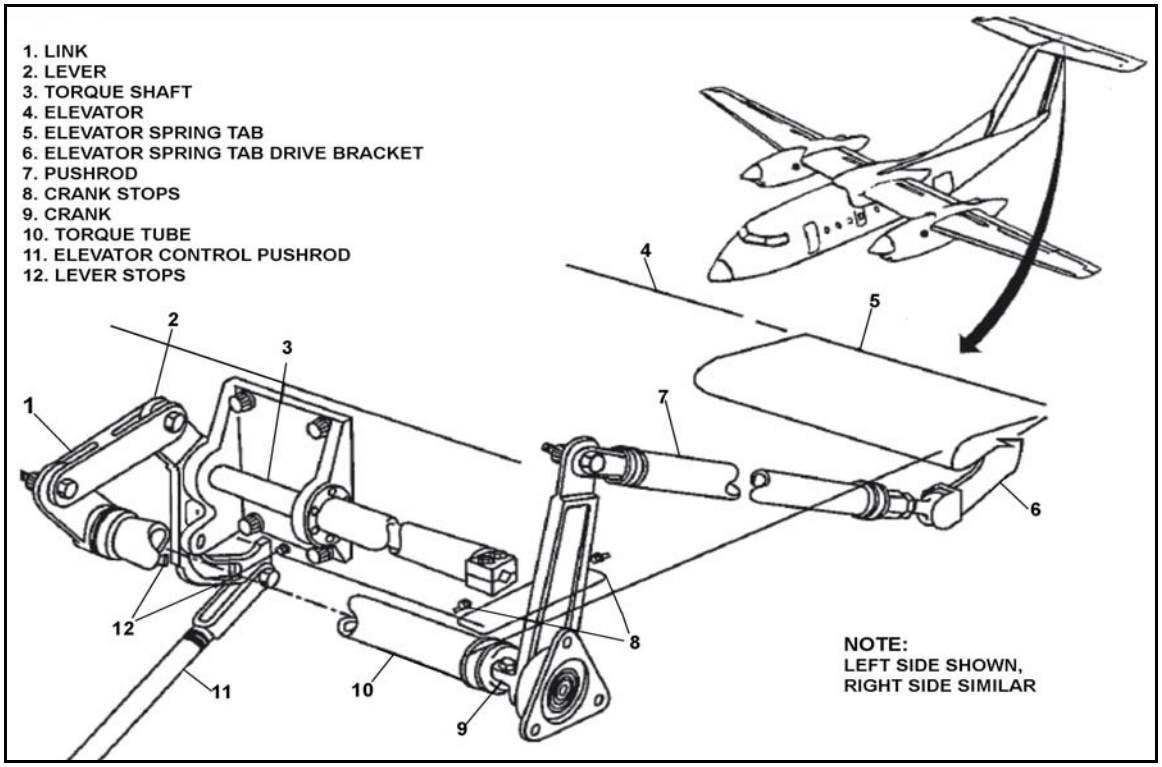

Figure 2. Elevator control

Maintenance History

Between 22 July and 07 August 2004, the aircraft had been at the Air Canada paint shop in Toronto to be repainted. The aircraft accumulated approximately 162 hours of flight time and 162 cycles between the time this maintenance was completed and the occurrence flight.

The maintenance work package "Preparation for Aircraft Paint Visit" had three sections. The first section covered the preparation of the aircraft for painting. This section included items such as draining the toilet, disconnecting the batteries, and removing the static wicks. These items were completed on 22 July 2004. The second section was the painting check sheet. The third section was the return to service section. This section included items such as reconnecting the batteries, servicing the lavatories, balancing the control surfaces and tabs, checking that control movements were free and clear, conducting a "L" (line) check, and conducting a full-power engine run. This section required two signatures to signify its completion. One signature, dated 08 August 2004, signified that an independent inspection of the flight controls had been completed. The other signature, dated 09 August 2004, signified that all the work had been completed properly.

When the right elevator spring tab was checked, it was nose heavy and required rebalancing. This work was not noted on the check sheets. Checking the balance of the elevator spring tab is accomplished by disconnecting the tab drive bracket (Figure 2, item 6) from the pushrod (Figure 2, item 7) and attaching a specific weight to the trailing edge of the tab. The rebalancing was accomplished by removing the steel balance weights and grinding some material from the

upper surface of the weights. Because this is "work that disturbs engine or flight controls" as specified in Section 571.10 of the *Canadian Aviation Regulations* (CARs), there is a requirement for an independent inspection. The independent inspection was carried out the following morning.

Maintenance crews were brought in from Halifax, Nova Scotia, to return the aircraft to service. On 07 August 2004, the aircraft maintenance engineer (AME) who balanced the spring tab started his normal work shift in Halifax at 0700 Atlantic daylight time, and that morning was asked to go to Toronto to work on the aircraft coming out of the paint shop. He arrived in Toronto in the afternoon, and began working on C-FGRP. Late at night on 07 August 2004, he completed the removal and reinstallation of the weights from the spring tab balance arm. The AME who conducted the independent inspection of the controls arrived from Halifax on the evening of 07 August 2004, and the first task he completed the following morning was the independent inspection of all the aircraft flight controls.

Training in Emergency Procedures

Part of the DHC-8 pilot recurrent training involves dealing with flight control jams. In a DHC-8 flight simulator, pilots are routinely given a situation where the elevator control is jammed and will not move. The training is designed to familiarize the pilots with the QRH procedures, to practice pulling the elevator disconnect, and to fly the aircraft using the unjammed elevator control circuit. The training does not include a jammed spring tab scenario.

The SOPs include emergency procedures for pitch control jam, elevator control and trim malfunction, and manual elevator trim failure. The pitch control jam procedure from the SOPs is stated below.

> (19) Pitch Control Jam
>
> On recognizing a jam in the elevator control circuit, both pilots will attempt to overcome the jam with firm elevator pressure. If unable to obtain elevator control the PF will call for relax pressure and pull and rotate the PITCH DISCONNECT HANDLE 90 degrees. The pilot with the free control wheel will call "**My control**".
>
> Note: The PF may command the PNF to pull the pitch handle if required.
>
> If the jam occurs below level off height, at level off height the PF will command the PNF to leave the flaps alone and set climb power. The PNF will disarm the autofeather, select the taxi and approach lights off, select ignition normal if appropriate, turn the bleeds on and set climb power. Through 1000 feet HAA[2] the PF will request the Emergency Checklist followed by the After Takeoff Check.
>
> Caution: Do not engage the autopilot and do not exceed 150 KIAS or speed at which jam occurred whichever is greater.

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[2] HAA – height above aerodrome

WARNING: IF CLOSE TO THE GROUND OR AIRCRAFT CONTROL IS IN JEOPARDY, CONSIDERATION SHOULD BE GIVEN TO IMMEDIATELY ACTIONING THE PITCH DISCONNECT VERSUS PUSHING OR PULLING.

Analysis

The balancing and the independent inspection of the spring tab were carried out approximately one month before the occurrence; therefore, many of the specific details about how the work was done were not available. However, the top of the jammed weight had been ground down, confirming that it had been removed at least once to grind material off in the attempt to balance the spring tab. After the weights had been adjusted, they would be reinstalled and the tab rechecked for balance.

Although it is possible that the nuts and washers were not reinstalled for the balance check, it is more likely that they were installed but left loose intentionally to facilitate re-removal of the weights should additional grinding be required. In any event, the final step of tightening them was overlooked. Without the nuts installed, the bolts migrated out of the weights, and when the outboard weight fell off, the bolts jammed on the top surface of the elevator.

The task of balancing the spring tab was completed late at night by an AME who had travelled from Halifax and then worked a long day. The independent inspection that was completed the next morning did not discover the loose nuts; no explanation for this was found.

There was nothing in the training provided to the flight crew nor in the QRH that would have helped them to recognize the symptoms of a jammed spring tab. As well, they would not have been aware that such a condition could potentially overstress the tail of the aircraft due to the elevator loads no longer being symmetrical. This lack of information contributed to them continuing the flight to destination rather than landing at the nearest suitable airport. From their training, they would be predisposed to assume that a pitch control jam would result in an inability to move the control column. Therefore, they did not associate the difficulty in holding the control column forward as an indication of a pitch control jam. Instead of slowing the aircraft to minimize the abnormal forces on the aircraft, they continued with the normal climb procedures, including retracting the flaps and allowing the aircraft to accelerate.

After declaring an emergency because of the pitch control anomaly, but without being able to determine the cause of the anomaly or whether there was any damage to the aircraft or its controls, the flight crew overflew a suitable aerodrome where an emergency landing could have been accomplished. The QRH checklist for a pitch control jam did not indicate that a landing should be conducted at the nearest suitable aerodrome.

Findings as to Causes and Contributing Factors

1. The nuts securing the counter balance weight to the weight arm were not tightened. They fell off, which in turn allowed the bolts to migrate out of the weights. When the outboard weight fell off, the bolts jammed on the top surface of the elevator.

2. The independent inspection was not adequate, in that it did not reveal that the securing nuts were not tight.

Findings as to Risk

1. The training and checklists provided to the flight crew members did not provide them with sufficient means to identify the nature of the anomaly, nor were they made aware of the potential for overstressing the aircraft with increased airspeed.

2. The *Quick Reference Handbook* checklist for the pitch control jam did not indicate that a landing should be conducted at the nearest suitable aerodrome.

Safety Action

Air Canada Jazz

Air Canada Jazz conducted an internal investigation into this occurrence using a maintenance error decision aid process. This process identified a number of deficiencies, and the company has modified some of its procedures to improve the quality of the work and to reduce the chance of a maintenance error going undetected. Changes include the following:

- The inspection form "Preparation for Aircraft Paint Visit" was amended to record additional information that will indicate if it was necessary to adjust the balance weights when the control surfaces and tabs were checked for balance.

- A communication was transmitted to all maintenance personnel to restate the requirements and expectations of an independent inspection.

- Procedures are being drafted to monitor, approve, and limit extended amounts of overtime.

- Flight crew training syllabuses are being modified to include information and procedures for "soft" jam situations.

Bombardier

Bombardier Inc. issued All Operator Message No. 789. This message is intended to raise the awareness of output/soft jam possibilities in the flight controls of DHC-8-100/200/300 aircraft so that flight crews will proceed immediately to the control jam checklist and not allow the aircraft to accelerate.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 03 November 2005.