

AVIATION INVESTIGATION REPORT

A98Q0057

JAMMING OF ELEVATORS IN FLIGHT

AIR ALLIANCE

DE HAVILLAND DHC-8-102 C-FHRC

QUÉBEC/JEAN-LESAGE INTERNATIONAL AIRPORT, QUEBEC

25 APRIL 1998

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 Occurrence Report

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Report Number A98Q0057

Summary

The Dash 8-102 aircraft, registration C-FHRC, serial number 209, was making an instrument flight rules flight between Québec/Jean Lesage International Airport, Quebec, and Montréal/Dorval International Airport, Quebec. During climb-out, the flight crew had been cleared to maintain an altitude of 14 000 feet above sea level (asl). During climb, the aircraft was under manual control by the first officer. At about 12 000 asl, he noticed that the elevator controls were jammed. The pilot-in-command took the aircraft's controls, also found the elevators jammed, and noted that the elevator trim was at the nose-down limit. He tried to disconnect the left and right elevators by using the pitch disconnect handle as prescribed by the aircraft's flight manual, but without success. He reset the pitch disconnect system. He then engaged the autopilot, which disengaged automatically a few seconds later. The flight crew decided to turn back to Jean Lesage Airport and requested emergency services on the scene. Elevator trim and engine power were used to control the aircraft until landing, which proceeded without further incident. While taxiing, the pilot-in-command checked the elevator controls and found them to be working normally.

Ce rapport est également disponible en français.

Factual Information

The flight crew was certified and qualified for the flight in accordance with existing regulations.

The Dash 8-102 was arriving from a flight from Wabush, Newfoundland, and was stopping at Jean Lesage Airport for about 40 minutes. During that time, the weather conditions observed by Environment Canada were overcast sky with a temperature of one degree Celsius and a dew point of zero degrees Celsius, accompanied by light snow and rain, and fog reducing visibility to one mile. The wind was from the west at less than five knots. On take-off, the weather conditions were similar, except for the dew point, which had risen to one degree Celsius. The accumulation on touchdown might have been water or wet snow, but it was not measured.

The pilot-in-command performed a walk-around inspection of the aircraft about 30 minutes before take-off. During the inspection, no snow accumulation was observed on the aircraft. Less than five minutes before take-off, the pilot-in-command left the aircraft and again checked that there was no snow accumulation on the aircraft. Following that final inspection, the crew was confident that it was not necessary to de-ice the aircraft. The aircraft taxied for take-off without application of de-icing or anti-icing fluid.

Before starting the take-off roll, the first officer, who was at the controls, checked the travel of the flight controls and did not notice any resistance. The aircraft took off without incident. Once the climb attitude was attained, the elevator trim was used to alleviate the normal pitch control forces created by any speed or attitude change until approximately 12 000 feet asl.

At about 12 000 feet asl during the climb, the first officer advised the captain that the flight controls were stiffer than usual. The captain took control of the aircraft and realized that the controls were jammed. Both pilots tried to unjam the elevators by applying increased force on the control column, but without success. The pilot-in-command referred to the *Quick Reference Handbook* procedures for jammed elevators so as to maintain control of the aircraft and try to unjam the elevators. By using the pitch disconnect handle, the pilot-in-command disconnected the left and right elevators, but that did not unjam the controls. He, therefore, reset the pitch disconnect system. He then tried to engage the autopilot, but it disengaged automatically between 20 and 30 seconds later.

The crew declared an emergency to the Montréal control centre and requested to be routed to Jean Lesage Airport. The pilot-in-command was able to control the attitude and desired vertical speed using elevator trim and engine power. While descending through 6 000 feet asl, the pilot-in-command felt the aircraft's nose suddenly lift up. He immediately corrected the aircraft attitude by varying the engine power and using the elevator trim. He continued the descent for landing with zero degree flaps in order not to disturb the aircraft attitude. The aircraft landed without further incident. Upon landing, the pilot-in-command checked the elevator controls and found them to be completely free of any restriction.

As soon as the passengers had deplaned, the aircraft was inspected by the company's technicians. All the access panels to the elevator controls, the elevator trims, the control lock system, and the autopilot were removed to find any signs of obstruction or anything else likely to jam the flight controls. This inspection did not reveal any anomalies.

The carrier's technical staff then inspected the surfaces of the horizontal stabilizer and the elevators. This inspection revealed that the leading-edge surfaces of both left and right elevators had large dribbles of rough-textured paint. The paint build-up reduced the space between the leading edge of the elevators and the

trailing edge of the stabilizer to nearly 0.125 inch in places. The drips were orientated crosswise to the direction of the airflow. The leading edges of both elevators showed drips composed of paint and sanding dust that were a little over 0.125 inch thick and 0.375 inch wide in places. Upon making this discovery, the technicians sanded the paint drips from the elevators to restore the evenness of the surface. The space between the trailing edge and the leading edge was returned to the aircraft manufacturer's specified standards of between 0.150 and 0.250 inch.

The trailing-edge surface of the stabilizer is studded with rivet heads and access plugs that reduce the space between the two surfaces, that is, the stabilizer and the elevator. The rivet heads and access plugs are conducive to the adherence of ice. The trailing-edge surfaces had an even, nonporous finish. The drips of rough-textured paint along the leading edges originated when the aircraft was painted a few years earlier.

The aircraft manufacturer describes in the aircraft's maintenance manual all the criteria defining the critical flight surfaces. According to the manufacturer's manual, the complete surface of the elevators and the stabilizer must meet the critical-surface finish standards.

Evenness of the critical surface is defined by several criteria, namely, pronounced demarcation or undulation of the surface and direction relative to the airflow. The drips on the elevator leading edges were defined by undulation in the direction of the airflow and should not have exceeded a height of 0.020 inch between the peaks and cracks or a length of 0.005 inch.

Canadian Aviation Regulation 602.11, relating to contamination of the critical surfaces of aircraft, specifies that a flight may not be started in existing frost, ice or snow conditions unless the aircraft has been inspected to determine whether any frost, ice or snow is adhering to its surfaces. Transport Canada publication TP 10647E *When in doubt...* specifies that there must be nothing on the surface of the aircraft that is not part of it. This means there must be no contamination by ice, snow, mixture of snow and rain, freezing rain, hail, insects, mud, grass, water, spilled fluid, or other contaminant. To determine whether there is any contamination of the surfaces, Transport Canada proposes a checklist of what to check. The manufacturer recommended the wing, horizontal and vertical tail, and their respective control surfaces be checked. Once the inspection reveals that the aircraft is not contaminated and is adequately protected, Transport Canada indicates that the aircraft should be cleared to take off as soon as possible. Transport Canada further indicates that the inspection is particularly important if there is any precipitation or if the relative humidity is high. This was the situation at Québec while the aircraft was on the ground and taking off.

The conditions conducive to icing or ice accretion are defined by the aircraft manufacturer in the aircraft's flight manual. It had also issued several service letters concerning icing precautions and procedures to be followed. Service Letter SL-12-006 Rev A, issued in October 1996 to all groups of technical and operations personnel, recalls that the aircraft must be free of any contaminant and must be clean and remain clean before take-off. Another letter, dated November 1996, recounts an incident that occurred under similar temperature conditions without the stabilizer and the elevators being de-iced, resulting in jamming of the elevators. The experience was transmitted to all Dash 8 operators with the recommendation to de-ice the aircraft completely in icing conditions. Manufacturer's service letters have been re-issued yearly and updated to reflect current icing precautions and procedures, practices, and performance adjustment following the application of de-icing/anti-icing fluids.

The definition of icing conditions found in the operator's standard operating procedures manual reads as follows:

Icing conditions exist when the SAT (Static Air Temperature) on the ground and for take-off is 10°C or below, or SAT in flight is 5°C or below, and visible moisture in any form is present (such as clouds, fog with visibility of one mile or less, rain, melting snow or ice crystals). Icing conditions also exist when the SAT on the ground and for take-off is 10°C or below when operating on ramps, taxiways or runways where snow, ice, water or slush may be ingested by the engines or freeze on engines, nacelles or engine sensing probes.

This definition corresponds to the definition given by the aircraft manufacturer.

The crew had taken recurrent training on aircraft critical-surface contamination. This course is given by the company from time to time to all flight personnel and ground maintenance staff.

The Allied Signal flight data recorder (FDR) was turned over to the TSB Engineering Laboratory in Ottawa. Analysis of the flight data revealed anomalies with the right elevator position sensor at the start of the flight. From the take-off to the top of climb, the data are considered invalid due to the extreme nose-up deflections recorded and significant noise during this period. The cause of the elevator jam was not apparent from the flight data.

The FDR revealed that the aircraft was controlled during descent by varying engine power and by the elevator trim. It was noted that the action of the trim had relatively little effect on control of the aircraft. As a result, shortly after the occurrence, the aircraft manufacturer issued to all Dash 8 operators a *Safety of Flight Supplement* reviewing elevator trimming procedures. The manufacturer's document stresses that the crew must not select the elevator trim in the full nose-up or full nose-down position. Either of these two conditions would likely make it hard to regain control of the aircraft, should the elevator suddenly become free, with the potential for exceeding the aircraft's manoeuvring load limit during recovery.

Analysis

The observed weather conditions during the aircraft's stop at Québec and on take-off met the icing-condition criteria specified by the aircraft manufacturer, the operator, and Transport Canada. There was wet snow and rain, and the temperatures were conducive to icing conditions. Given the weather conditions prevailing when the aircraft was on the ground, the decision to take off without de-icing the aircraft was questionable.

The use of the elevator trim to alleviate the normal pitch control forces during the climb made it impossible to recognize the imminent jamming of the elevators sooner. It was a potentially dangerous condition to control the aircraft with the elevator trim when the elevators were jammed. Should the elevators have suddenly become free with the trim in the full nose-down position, the aircraft would have quickly nose-dived. On approach and especially at low altitude, this situation could potentially lead to impact with the ground.

The surface finish of the elevator leading edges did not comply with the manufacturer's standards. This was the only observed factor that could have allowed the combination of rain and wet snow to freeze and adhere, accumulate, and cause an elevator jamming condition. No controls or flight controls associated with the operation of the elevators showed any abnormality.

The following laboratory report was completed :

LP 45/98—FDR Analysis.

This report is available upon request from the Transportation Safety Board of Canada.

Findings as to Causes and Contributing Factors

1. The accumulated ice on the surfaces caused the stabilizer to jam.
2. The walk-around inspection done by the pilot-in-command did not make it possible to recognize the presence of wet snow in the opening between the stabilizer and the elevators.
3. No application of de-icing or anti-icing fluid was requested or performed prior to take-off.
4. The atmospheric conditions were favourable to contamination of the critical surfaces and met the icing-condition criteria set forth by Transport Canada, the carrier, and the aircraft manufacturer.
5. The leading edges of the elevators had surface-finish irregularities exceeding the manufacturer's standards and thus favoured ice build-up.
6. The paint drips were porous in texture and allowed ice to adhere to the elevator leading edges.

Other Findings

1. The crew had received periodic training on aircraft critical-surface contamination.
2. No mechanical anomalies of the elevator controls were observed that could have affected the operation of the elevators.
3. Upon landing, the pilot-in-command checked the elevators and found them to be completely free of any restrictions.
4. The flight crew was certified and qualified for the flight in accordance with existing regulations.

Safety Action

On 5 May 1998, Bombardier sent a letter to all operators and its regional representatives summarizing the Québec occurrence and reminding them of the proper use of the elevator trim.

On 20 May 1998, Bombardier issued a Dash 8 *Safety of Flight Supplement* for insertion in Chapter 4 of the *DHC-8 Series 100 Operating Data Manual*. The document reminds pilots that the elevator trim does not have the authority to overcome a frozen elevator.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 June 2000.