

AVIATION INVESTIGATION REPORT
A03O0302

ELEVATOR CONTROL RESTRICTION AT TAKE-OFF

AIR CANADA JAZZ
de HAVILLAND DHC-8-102 C-GONJ
OTTAWA/MACDONALD-CARTIER INTERNATIONAL AIRPORT
OTTAWA, ONTARIO
04 NOVEMBER 2003

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

Elevator Control Restriction at Take-off

Air Canada Jazz
de Havilland DHC-8-102 C-GONJ
Ottawa/Macdonald-Cartier International Airport
Ottawa, Ontario
04 November 2003

Report Number A03O0302

Summary

On 04 November 2003, the de Havilland DHC-8-102 aircraft (registration C-GONJ, serial number 095), operating as Air Canada Jazz Flight 8946, was on a scheduled flight from Ottawa/Macdonald-Cartier International Airport, Ontario, to Montréal International Airport (Dorval), Quebec, with 19 passengers and a crew of three. The aircraft left the gate and proceeded to the de-icing pad where it was de-iced to remove ice that had accumulated during the previous flight and freezing rain that had accumulated while the aircraft was on the ground at Ottawa. The aircraft then taxied to Runway 07 and was cleared for take-off. The crew carried out normal pre-take-off checks and at 1412 eastern standard time commenced the take-off run. On rotation, the pilot felt a restriction to movement of the pitch controls and, as a result, the pilot rejected the take-off.

After clearing the runway, the crew moved the elevator controls through their full range of movement and found them free of restriction. The aircraft returned to the gate where maintenance inspected the aircraft and found the controls operating properly and free of restriction. Some freezing rain drops and residual de-icing fluid were found on the horizontal stabilizer and the elevator surfaces, but there were no large pieces of ice. The aircraft was de-iced again and proceeded to Montréal.

Ce rapport est également disponible en français.

Other Factual Information

The aircraft and flight crew had been in Ottawa overnight and had flown a round-trip to the Toronto City Centre Airport, Ontario, earlier on the day of the occurrence. The return flight landed at Ottawa at approximately 1053 eastern standard time.¹ Freezing rain was encountered below 5000 feet on the approach and some ice accumulated. The aircraft was on the ground, parked outside, for approximately 2 hours 30 minutes prior to leaving the gate on the next flight, during which time there was precipitation in the form of light and moderate ice pellets, light freezing rain, and light rain.

Prior to boarding Flight 8946, the crew inspected the aircraft and observed ice on the critical surfaces, the nose, and the propellers and icicles on the trailing edges of the wings and horizontal tail. Light ice pellets and light freezing rain were falling at that time. Before engine start, the propellers were de-iced with Type I freezing point depressant (FPD) fluid. The engines were started at 1318 and the aircraft taxied from the gate at 1320, arriving at the de-icing ramp at 1324. There was a delay of approximately 30 minutes before de-icing started due to an aircraft ahead and a shift change at the de-icing facility.

De-icing using Type I fluid was carried out between 1353 and 1408. The aircraft was parked on a heading of 140 degrees magnetic. During the de-icing, there was a crosswind from the aircraft's left; 070° at 15 knots with gusts to 20 knots. Two trucks were used, initially positioned on either side of the fuselage behind the wings and in front of the tail. The truck on the left side de-iced the left wing while the truck on the right de-iced the right wing. The truck on the left moved to the nose of the aircraft to remove the ice from the previous flight while the truck on the right remained behind the starboard wing and de-iced both sides of the horizontal stabilizer and elevators. On completion of de-icing, de-icing personnel saw no ice on any aircraft surfaces. The crew was aware that a resumption of freezing precipitation before take-off would necessitate returning for further de-icing; however, no precipitation fell during de-icing or while taxiing for take-off.

When de-icing was complete, the de-ice lead advised the flight crew. They left the de-icing pad at approximately 1408 and proceeded to Runway 07 for take-off. The crew carried out normal pre-take-off checks, including a check of the controls, performed by the pilot not flying (PNF). The take-off run began at 1412. When attempting to rotate, the pilot flying (PF) felt a restriction to aft movement of the control yoke and rejected the take-off. After clearing the runway, a control check was carried out but there was no restriction.

The aircraft returned to the ramp. There was a delay of 30 minutes before the aircraft received a gate assignment and was shut down. By that time, freezing rain was again falling. A maintenance technician verified that the elevator controls were free of restriction and moving correctly, then inspected the top surface of the horizontal stabilizer. The technician found freezing rain drops and residual de-icing fluid, but no large pieces of ice. The aircraft, released by maintenance and de-iced, proceeded to Montréal, Quebec.

Ottawa airport weather reports indicated that precipitation, in the form of light ice pellets, rain, and freezing rain, fell during the period that the aircraft was on the ground between flights. There was no precipitation between 1339 and 1453, then light freezing rain resumed. The weather recorded at the time of the rejected take-off was as follows: wind 070°T at 15 knots with gusts to 20 knots; temperature -2°C, and no precipitation.

De-icing was carried out by Air Canada using two Global model 2110TE-EC-AP trucks equipped with a telescopic boom and articulating enclosed cab with a reach and height of 28 feet. Each truck was operated by a driver and a boom operator, and the overall operation was controlled by a de-icing lead. The lead had communication with the flight crew and with the truck drivers, and the truck drivers had communication with

¹ All times are eastern standard time (Coordinated Universal Time minus five hours).

their respective boom operators. Manning, qualifications, training, and procedures were in accordance with the Air Canada Jazz *Ground Icing Program* manual² and with the company operations manual (COM)³. A total of 503 litres of Type I fluid was used for the wings, tail, and nose, which reportedly is more than average but not inconsistent with the aircraft's exposure to freezing precipitation.

Both pilots held airline transport pilot licences and were appropriately qualified for this flight. They had received surface contamination training in accordance with company requirements, and both had adequate rest the previous night. There were no fatigue or duty-time related issues.

According to records, the aircraft was maintained in accordance with current regulations. There were no outstanding maintenance issues or indication of pre-existing mechanical failure or other condition that would have contributed to this incident. The aircraft was equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR) as required by *Canadian Aviation Regulations* (CARs). The CVR was recorded over during the subsequent flight and was not available for investigation.

FDR data are presented at Appendix A. The sample rate for the FDR was one sample per second. The following information was derived from the FDR:

1. During the control check, the FDR recorded the elevators moving from fully trailing edge down to near fully trailing edge up and back to neutral in less than three seconds, during which both elevators moved in unison. Full range of travel is 20° trailing edge down to 20° trailing up. It is likely that the elevators reached the full range of trailing edge up travel but were not recorded due to the rate of control movement relative to the sample rate of the FDR. The elevators were then held near neutral while the lateral controls were checked, during which a split of approximately 4° developed between the two elevators and remained until the elevators were returned to the fully trailing edge down position on completion of the control checks.

² Air Canada Jazz Ground Icing Program, dated 31 October 2003

³ Air Canada Jazz company operations manual, amendment 6, dated 31 October 2003

2. At the beginning of the take-off run, both elevators moved in unison to approximately 7.5° trailing edge down at 45 knots indicated airspeed (KIAS). As the aircraft accelerated, a split developed, the left elevator essentially not moving while the right elevator continued to move trailing edge up to a maximum of 2.2° up. The maximum split was 8° at 107 KIAS.
3. After the take-off was rejected, as the aircraft decelerated through 65 KIAS (the speed at which the PF normally releases the control yoke to use the tiller), the right elevator went full trailing edge down while the left elevator hung at about 10° trailing edge down for 10 seconds. At 50 KIAS, the elevators both moved abruptly to about 15° trailing edge up and back to full trailing edge down, consistent with the PNF locking the controls in accordance with normal rejected take-off procedures.
4. Both elevators moved in unison with no indication of hang-up when the controls were exercised through their range of movement after the aircraft cleared the runway.
5. During the subsequent take-off, when no elevator restriction was encountered, both elevators moved progressively to approximately 1.5° trailing edge down at 45 KIAS and to 1.5° trailing edge up by 65 KIAS. They remained at that position until 98 KIAS when the pilot initiated rotation for take-off; both elevators moved to over 10° trailing edge up. These normal elevator control positions are shown in Appendix A for comparison with the positions during the rejected take-off.

Dash 8 pitch control is effected by manually operated, spring-tab assisted elevators. The elevators are attached behind the horizontal stabilizer with a clearance of 0.15 to 0.25 inches between the leading edge of the control surface and the shroud on the trailing edge of the stabilizer. The left and right elevators are operated by independent mechanical control circuits that are normally interconnected at the control columns. There is a disconnect system to allow either side to operate independently of the other in the event of a malfunction. Control column inputs are transmitted through a series of cables, pulleys, bellcranks, push rods, torque tubes, and torsion springs to the elevator and to the spring tab that provides aerodynamic assistance to elevator movement. There is no cockpit indication of elevator position or of differences between the elevators.

The Dash 8 is certified⁴ in compliance with Federal Aviation Regulation (FAR) 25.1419 for flight in icing conditions subject to the aircraft being operated in accordance with the manufacturer's *Aircraft Flight Manual* (AFM).⁵ The AFM contains a warning as to conditions that could possibly exceed the capability of the ice protection system and degrade the performance and controllability of the aircraft. The AFM provides guidance as to the recognition of severe icing

⁴ Transport Canada Type Certificate Data Sheet A-142

⁵ *Aircraft Flight Manual*, PSM 1-81-1A

conditions and a procedure in the event that severe icing is encountered. The wording of the AFM is consistent with that required by a Federal Aviation Administration (FAA) airworthiness directive⁶ to U.S. operators concerning operation in icing conditions.

A service letter⁷ issued by the aircraft manufacturer reflects the need for the aircraft's critical surfaces to be free of contaminants. It also indicates the possibility that dehydrated anti-icing fluid residue will accumulate in the aerodynamically quiet area between the control surface and the shroud immediately ahead of it. It states that jams could be associated with freezing of rehydrated residue. An operating data manual supplement⁸ addresses icing precautions and de-icing procedures and provides performance adjustment following the application of de-icing and anti-icing fluids.

CAR 602.11, relating to aircraft icing, prohibits take-off with frost, ice, or snow adhering to any critical surface and requires that Part 705 operators establish a program that complies with CAR Standard 622.11, Ground Icing Operations, and operate in accordance with that program. Air Canada Jazz complies with the CAR requirement through its ground icing program as presented in the COM and its *Ground Icing Program* manual.

CAR Standard 622.11, Section 7 states that the operator's program must provide aircraft-specific instructions and procedures to be followed by flight crew and other personnel for detecting contamination on the critical surfaces of aircraft. Two types of inspection that meet regulatory requirements are defined. They are:

“critical surface inspection” – is a pre-flight external inspection of critical surfaces conducted by a qualified person [. . .] to determine if they are contaminated by frost, ice, or snow. Under ground icing conditions, this inspection is mandatory.

“pre-take-off contamination inspection” – is an inspection conducted by a qualified person, immediately prior to take-off, to determine if an aircraft's critical surfaces are contaminated by frost, ice, or snow. This inspection is mandatory under some circumstances [as specified in the operator's program].

CAR Standard 622.11, Section 7.1.3 provides additional guidance for the pre-take-off contamination inspection, allowing for inspection from the inside or outside of the aircraft, and allowing the use of representative aircraft surfaces to judge the extent of contamination. The inspection may be visual or tactile except that, for aircraft without leading edge devices, it must be tactile unless other procedures have been specifically approved. Where only a visual

⁶ Airworthiness directive 96-09-25, de Havilland Model DHC-7 and DHC-8 Series Airplanes, effective 11 June 1996

⁷ Bombardier Regional Aircraft Service Letter DH8-SL-12-006I, “Icing Precautions and Procedures,” dated 08 July 2003

⁸ Operating data manual supplement 24, “Icing Precautions and Procedures and Performance Adjustment for Ground Deicing/Anti-icing Fluid,” dated 05 September 2003

inspection is done, the operator's program is required to specify the conditions, such as weather, lighting, and visibility of critical surfaces, under which the inspection can be carried out.

The approved Air Canada Jazz *Ground Icing Program* manual and the COM state procedures for de-icing the Dash 8. There is a specific instruction to remove snow and ice between the elevator leading edges and all tabs and shrouds. The *Ground Icing Program* manual states that a critical surface inspection is mandatory under ground icing conditions and that "some aircraft" require a "tactile inspection of critical surfaces." For the Dash 8, the *Ground Icing Program* manual calls for a tactile inspection to check that dry snow has not adhered during layovers and for presence of ice in the engine intake prior to engine start. The COM requires a pre-take-off contamination inspection when minimum hold-over times are exceeded. For the Dash 8, the pre-take-off contamination inspection is a visual inspection by the pilot in the left seat of a representative surface, the left wing outboard roll spoiler. This inspection is considered to satisfy the intent of the tactile inspection called for by CAR Standard 622.11 for aircraft without leading edge devices.

CAR 705.124 requires that operators establish and maintain a training program that includes aircraft surface contamination training that, according to CARs Standard 725.124, includes training in in-flight icing recognition and operations in icing conditions. Transport Canada (TC) publications TP 14052E⁹ (E refers to English language, F would indicate French) and TP 10643E¹⁰ provide additional guidance for ground icing programs and for critical surface contamination training.

TP 14052 and TP 10643 both state that aircraft are not certified to fly in freezing rain conditions. TP 10643 indicates that CARs, the COM, and the AFM are the final authority in the case of conflict. TP 14052 states that it replaces all previous Commercial and Business Aviation Advisory Circulars (CBAACs) on the subject and must be included in the company training program. Two CBAACs¹¹ on the subject of airborne icing remain available on the TC Web site. CBAAC 0130R acknowledges that aircraft may encounter conditions that are outside the certification envelope and provides procedures for such circumstances, including procedures that may take precedence over operating guidance in aircraft flight manuals. TP 10643 provides no guidance for flight in severe icing beyond stating that aircraft are not certified to fly in freezing rain and it makes no reference to these advisory circulars.

In 1996, in a series of 18 airworthiness directives (ADs), including AD 96-09-25, applicable to transport category aircraft equipped with pneumatic de-icing boots and non-powered roll control systems, the FAA mandated changes to aircraft flight manuals to address flight in severe icing conditions. The preamble to these ADs states that "flight outside the icing certification envelope occurs during the normal service life of an airplane"; therefore, guidance is necessary for flight crews. FAA Technical Report DOT/FAA/AR-01/91, *A History and Interpretation of Aircraft Icing Definitions and FAA Rules for Operating in Icing Conditions*, dated November 2001, contains no linkage between operating rules and certification criteria, but states that there is confusion resulting from differences between icing intensity definitions and operating rules for flight in icing conditions. FAA advisory circular (AC) 25.1419-1¹² provides guidance for certification of aircraft for flight in known icing, including guidance as to the contents of the AFM. It specifically cites AD 96-09-25 as an appropriate means of providing information on flight in severe icing. In Canada, the certification standard for flight into

⁹ Transport Canada publication TP 14052, *Ground Icing Operations Update*, dated September 2003

¹⁰ Transport Canada publication TP 10643, *When in Doubt... Small and Large Aircraft - Aircraft Critical Surface Contamination Training*, sixth edition, dated December 2003

¹¹ Commercial and Business Aviation Advisory Circular (CBAAC) 0130R, *Revised Airborne Icing Training Guidance Material*, dated 15 June 1999, and CBAAC 0147, *Airborne Icing Update*, dated 02 November 1998

¹² FAA Advisory Circular 25.1419-1, *Certification of Transport Category Airplanes for Flight in Icing Conditions*, dated 18 August 1999

known icing¹³ is identical to that of the U.S.

Except as provided in CAR 602.07, which requires that aircraft be operated in accordance with the limitations in the AFM, no CAR prohibits flight outside envelopes or test limits contained in the certification standard of the aircraft. Certification standards¹⁴ do not require that atmospheric icing conditions associated with certification of ice protection equipment be presented in the AFM either as a limitation or otherwise. The Air Canada Jazz COM provides guidance and operating restrictions for flight in icing conditions. Take-off is permitted in freezing precipitation when the ground icing program is complied with. Freezing rain is defined as “to be avoided”; the operating restriction is not to operate in known severe icing. When moderate or severe icing conditions are forecast, Air Canada Jazz obtains pilot reports and SIGMETs/AIRMETs to verify actual conditions. Dispatch consults the pilot-in-command if there is doubt as to the ability to avoid such conditions.

A review of records revealed three previous incidents of interest involving Dash 8 aircraft: one in which elevators jammed in flight due to freezing of wet snow in the gap between the elevators and the horizontal stabilizer;¹⁵ one in which elevator spring tab movement restricted in flight, probably due to accumulation of ice or frozen snow in the gap between the spring tab and the elevator;¹⁶ and one in which restricted elevator spring tab movement was possibly due

¹³ TC Airworthiness Manual, Chapter 525, Section 1419 and Appendix C

¹⁴ TC Airworthiness Manual, Chapter 525, Subchapter G, “Operating Limitations and Information”

¹⁵ TSB report A98Q0057, Jamming of Elevators in Flight, Air Alliance, de Havilland DHC-8-102 C-FHRC, Québec/Jean-Lesage International Airport, Québec, 25 April 1998

¹⁶ TSB report A98A0055, Aircraft Control Difficulty, Air Labrador, de Havilland DHC-8-102 C-GAAN, St. John’s, Newfoundland, 28 April 1998

to freezing of rehydrated residue of previously applied anti-icing fluids.¹⁷ Freezing of rehydrated residue was also implicated in an occurrence involving a BAe 146 aircraft, which has a similar elevator control system.¹⁸

Analysis

The analysis will examine the nature of the control restriction, its origin, including the possible influence of freezing rain, and the residual risk in view of the inherent limitations of procedures and regulations that are aimed at reducing the hazards of aircraft icing.

FDR data indicated that something had physically interfered with movement of the left elevator. In the absence of a mechanical problem or other foreign object in the flight control system, the investigation focussed on icing. Based on the mechanical arrangement of the elevator controls and on previous occurrences, icing could have affected the controls in the following ways:

- Movement of the left elevator spring tab may have become restricted by snow, ice, or frozen rehydrated anti-icing fluid residues. This was rejected because the FDR already showed discrepancy in elevator movement during the control check at taxi speed, too slow for the tab to have an influence, and there was no indication of contaminants during post-occurrence inspections.
- Ice may have formed on the elevator horn and interfered with elevator movement. This type of ice is associated with in-flight icing adhering and building up from the leading edge of the horn. This possibility is not supported by the transitory nature of the restriction and the lack of ice on the horn when it was inspected after the incident.
- Ice may have been present in the gap between the elevator and the shroud at the trailing edge of the horizontal stabilizer. Previous occurrences have shown that contamination in this location can interfere with elevator movement by jamming between the elevator and the shroud. This was considered the most likely method of interference in this occurrence.

In view of the initially unrestricted movement of the elevator, the transitory nature of the restriction, and the lack of contaminant in the location during post-occurrence inspection, it was considered unlikely that contamination was frozen in a fixed position in the gap. Rather, a remnant of ice was likely floating in the anti-icing fluid on the left elevator. During the control check, it probably moved into the gap between the elevator and the shroud at the trailing edge of the stabilizer and caused the discrepancy that was recorded by the FDR between left and right elevator position during the lateral control check. The remnant of ice did not need to be very large; the clearance between the shroud and the elevator is only 0.15 to 0.25 inches as shown in Figure 1. In view of the freezing rain on the previous approach and on the ground between flights, it was likely clear ice, and it escaped visual detection during de-icing. When the elevator trailing edge was moved from the trailing edge down position (the locked position prior to this point of the flight as shown in Photos 1 and 2) to the trailing edge up position (as shown in Photo 3) during the control check, the ice likely migrated forward and lodged between the elevator and the shroud. When the pilot checked the lateral controls, the elevator was approximately neutral, being held without any restraining or locking device against its own weight and wind gusts with no intentional movement. Under these conditions, the elevator position discrepancy was not discernable by feel to the pilot. There is no cockpit indication of elevator position or of differences between the elevators.

¹⁷ United Kingdom's Air Accidents Investigation Branch (AAIB) Bulletin No. 12/2003, de Havilland Canada DHC-8-311 G-BRYJ, 02 March 2003

¹⁸ United Kingdom's AAIB Bulletin No. 2/2004, BAe 146-200 G-JEAX, 12 December 2002

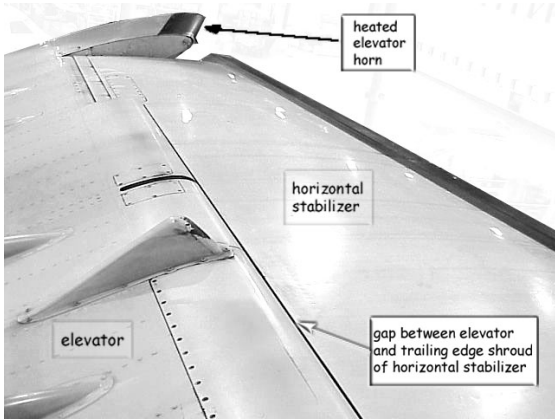


Photo 1. Left horizontal stabilizer with elevator trailing edge down

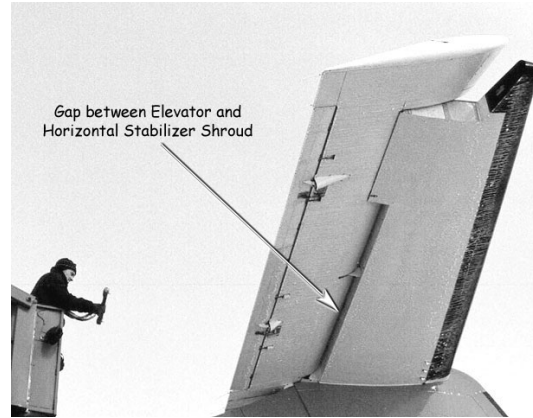


Photo 2. Underside of stabilizer showing gap, controls in locked position

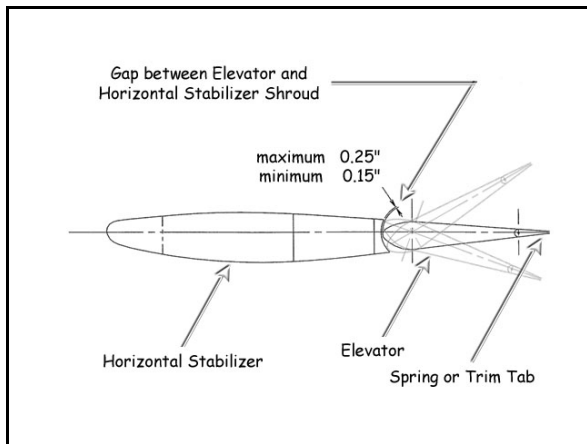


Figure 1. Horizontal stabilizer and elevator cross section

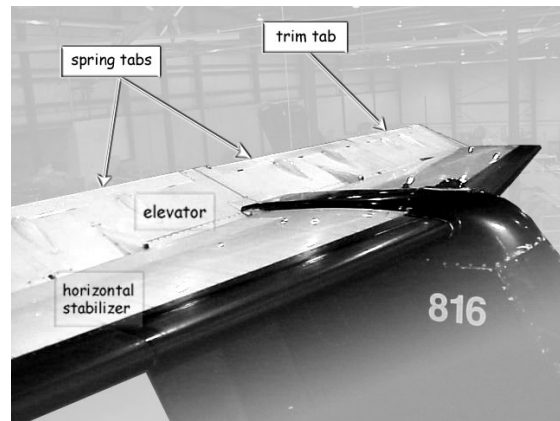


Photo 3. Horizontal stabilizer with elevator in trailing edge up position

The ground de-icing program is intended to ensure that the critical surfaces of an aircraft are free of ice and contaminants at take-off. It relies on the aircraft being de-iced in accordance with the operator's approved procedures and inspected prior to take-off. In this occurrence, there was a minor deviation from usual practice when both sides of the tail were de-iced from one side of the aircraft. The procedure was coordinated between the boom operators, the icing lead, and the flight crew in order to reduce the total time for the de-icing process. The equipment was capable; the telescopic boom had adequate reach to put the boom operator in the normal position required to de-ice the aircraft. There was nothing to indicate that the procedure used in this instance influenced the occurrence; however, the operator has taken steps in the interests of standardization to ensure that, when two trucks are used, they operate symmetrically.

The Air Canada Jazz ground de-icing program relies on visual inspection by the boom operator to confirm that the critical surfaces are free of contamination after the aircraft is de-iced. A small remnant of clear ice would have minimal visual contrast between it and the wet elevator surface; therefore, it may not be detected despite due diligence and proper qualification of de-icing personnel. While such an ice remnant would most often blow off when airspeed increases during the take-off, there is a risk that it could migrate into an aerodynamically quiet location such as between control surfaces, as it likely did in this occurrence, and where its presence would cause a control jam in aircraft without power controls.

The investigation considered if a pre-take-off contamination inspection could have been an effective defence against this occurrence. In this occurrence, it was not carried out and it was not required because there had been no precipitation since completion of de-icing and there was no other requirement in the Air Canada Jazz COM to perform one. Visual examination of the left wing outboard roll spoiler, the representative surface, would not reveal, nor is it intended to reveal, ice elsewhere that had previously escaped detection. The Air Canada Jazz COM does not require a tactile, pre-take-off contamination inspection, but if it did, it would focus on the upper surface and leading edge of the wing and probably would not detect a fragment of ice on the tail. The practicality of a tactile inspection including the horizontal stabilizer and elevator of a T-tail aircraft immediately before take-off is doubted. It is concluded that a pre-take-off contamination inspection is not likely to offer an effective defence in the occurrence circumstances.

The control check performed by the flight crew prior to the rejected take-off was consistent with company SOPs. However, the aircraft manufacturer considered that the rate of elevator movement was too rapid to reliably detect restrictions to the tabs and/or torque tubes. The AFM did not present information that would make pilots aware of this. The manufacturer has since issued revised guidance¹⁹ that calls for slow, smooth control checks following application of de-icing or anti-icing fluids. The revised procedure will improve the effectiveness of the control check, but it cannot detect ice that has not migrated between the control surfaces. In this occurrence, the elevator restriction was not evident in the FDR until after the pitch control check had been completed.

The presence of an undetected remnant of clear ice on an aircraft critical surface after de-icing prior to take-off is an unsafe condition for which the existing defences are inadequate to preclude beginning to take off. The adverse consequence is that the ice may migrate between control surfaces. For aircraft without power controls, this would be perceived by the pilot as a control jam on rotation. Based on the lack of previously documented occurrences of this nature, this is considered an unlikely event. Once the aircraft is airborne, ice of this nature would probably have blown off the aircraft. An airborne jam would be most improbable and procedures exist to respond safely to that situation. The correct pilot response to a control restriction at rotation is to reject the take-off. In most operations on the Dash 8 aircraft, decision speed (V_1) and rotation speed (V_R) are equal and aircraft operated in accordance with CAR 704 or 705 are assured of having sufficient stopping distance available to safely reject the take-off. If V_1 is less than V_R , then the aircraft would not be assured of stopping safely and the potential exists for severe injury and major aircraft damage. For the occurrence flight, V_1 and V_R were both 92 KIAS.

The adequacy of guidance for flight in freezing rain conditions was examined since the source of the ice may have been freezing rain from the preceding flight, and the planned flight was into forecast freezing rain conditions. A suggestion that these flights should not have been attempted because the forecast freezing rain was outside the certification envelope is not supported by CARs, the CBAACs that are still posted on the Web site, the AFM, or the COM.

There is ambiguity in the manner that this issue—flight in freezing rain and operating in icing conditions—is presented in the guidance publications TP 10643 and TP 14052. They both focus mainly on the ground icing program, but both also contain material relevant to in-flight icing. CARs standards place operations in icing and recognition of in-flight icing within the scope of surface contamination training, which is the purview of TP 10643, although TP 10643 acknowledges that other guidance may supersede it. TP 14052 presents itself as a higher authority when it states that it replaces all previous CBAACs and “must” be included in the company training program. Although the intent is probably limited to ground icing training, CAR Standard 725.124 does not recognize ground icing training separately from surface contamination training, within the scope of which are operations in icing and recognition of in-flight icing.

¹⁹ de Havilland Temporary Revision No. 21 to PSM 1-8-1, Dash 8 series 100 Operating Data, “Icing Precautions and Procedures and Performance Adjustment for Ground Deicing/Anti-icing Fluid,” dated 12 January 2004

The material in the TPs is not technically wrong and did not contribute directly to this occurrence. However, the failure to discriminate between certification criteria and operating rules and the lack of reference to the two CBAACs may result in the following:

- a false impression that there is a regulatory prohibition against flight in freezing rain;
- a reduction of the conspicuity of important safety material relevant to such operations; and
- a differing understanding as to the hazards and procedures involved in aircraft operations in icing conditions.

Finding as to Causes and Contributing Factors

1. A remnant of clear ice most likely migrated into the gap between the nose of the left-hand elevator and the shroud at the rear of the stabilizer when the elevator was moved trailing edge up during control checks and interfered with movement of the elevator when the pilot attempted to rotate for take-off.

Finding as to Risk

1. Existing defences cannot preclude the presence of undetected remnants of clear ice on an aircraft critical surface that is wet with de-icing fluid after de-icing. This ice may interfere with control movement during take-off and result in the pilot rejecting the take-off in aircraft without power controls; resulting in risk of severe injury or major damage for operations where decision speed (V_1) is less than rotation speed (V_R) and the aircraft cannot stop on the remaining runway.

Other Finding

1. Transport Canada guidance documents TP 10643 and TP 14052 present incomplete information concerning flight in freezing rain and operations in icing conditions. As a result, flight and ground crews may develop a differing understanding of the hazards and procedures involved in aircraft operations in icing conditions, and flight crew may not be aware of important safety material relevant to flight in icing conditions.

Safety Action Taken

The aircraft manufacturer issued a revised procedure for control checks following application of de-icing or anti-icing fluids.

In the interests of standardization, the operator has taken steps to ensure that, when two trucks are used to de-ice an aircraft, they operate symmetrically.

The operator has incorporated lessons from this occurrence into flight crew briefings on winter operations and has specifically highlighted the manufacturer's recommendation as to flight control checks.

The operator has amended the standard operating procedure for the Dash 8 to include a new requirement for a control check to be performed after application of de-icing and anti-icing fluids. The check requires slow stop-to-stop movement of the controls, looking for restrictions or unusual forces, and is in addition to the control check required immediately before take-off.

NAV CANADA has taken action to correct the use of obsolete precipitation codes in the remarks section of weather reports. The weather reports that are provided to pilots in METAR format are generated by computer from observations that are encoded by the observer in the previous SA format using the former codes. The remarks section of the report is essentially free text that is not translated into METAR code. NAV CANADA is in the process of converting the weather observation documentation from the SA (North American) format to the METAR (ICAO) format. This change will take place on 15 June 2005, and will reduce the inadvertent occurrence of SA codes in METAR observations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 14 March 2005.

Visit the Transportation Safety Board's Web site (www.tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Flight Data Recorder Information

