Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A02O0349

AIRCRAFT DIFFICULT TO CONTROL

JAZZ AIR INC

de HAVILLAND DHC8–311, C-FACF

TORONTO/LESTER B. PEARSON INTERNATIONAL AIRPORT,

TORONTO, ONTARIO

24 OCTOBER 2002

Canada

Aviation Investigation Report

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Jazz Air Inc.
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Toronto/Lester B. Pearson International Airport
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Summary

The de Havilland DHC8 (registration C–FACF, serial number 259) was being operated by Jazz Air Inc. as Flight JZA7956 from Toronto, Ontario, to Windsor Locks, Connecticut (KBDL), U.S.A. The aircraft departed from Runway 06L at Toronto/Lester B. Pearson International Airport (LBPIA), Ontario, at 1950 eastern standard time on the scheduled night instrument flight rules flight. During the take-off run, a three-foot piece of the wing leading edge (with the de-ice boot attached) separated from the left wing. The flight crew noticed a vibration on the flight controls during the initial climb after take-off and elected to return to Toronto/LBPIA. Air traffic control received a report of debris on Runway 06L, and the DHC8 aircraft leading-edge piece was retrieved. The aircraft landed without further incident on Runway 06L, with emergency response vehicles on standby. When the leading-edge section was examined, it was determined that the 14 screws that secure the leading-edge section to the bottom of the wing were missing.

Other Factual Information

History of the Flight

The flight crew arrived in Toronto, Ontario, from Cleveland, Ohio, at 1826 eastern standard time[1] in a DHC8–100 aircraft and planned to depart at 1925 for Windsor Locks, Connecticut, U.S.A., as Flight 7956. However, an earlier flight to Windsor Locks had been cancelled, and the passengers from that flight had been transferred to Flight 7956. The increased passenger load necessitated a change to a larger aircraft, a DHC8–311. One consequence of changing aircraft for the return trip to the U.S.A. was that the flight crew now had to pass through U.S. Customs and Immigration. This was not problematic, but it was time consuming, and there was no extra time if the crew was to meet the scheduled departure time. While the captain checked the necessary paper work for the flight, including the weather, flight plan and aircraft maintenance records, the first officer completed a walk-around inspection of the aircraft.

The aircraft log-book entries included the statement, "Work package #446 completed. (opt–3, L–check)." There was no other information provided that would indicate to the flight crew what maintenance actions had been accomplished on the aircraft. The L–check was a known 75-hour recurrent inspection that was not particularly complex; however, the aircraft had been with maintenance for three days, an indication that the OPT–3 check involved extensive maintenance work on the aircraft.

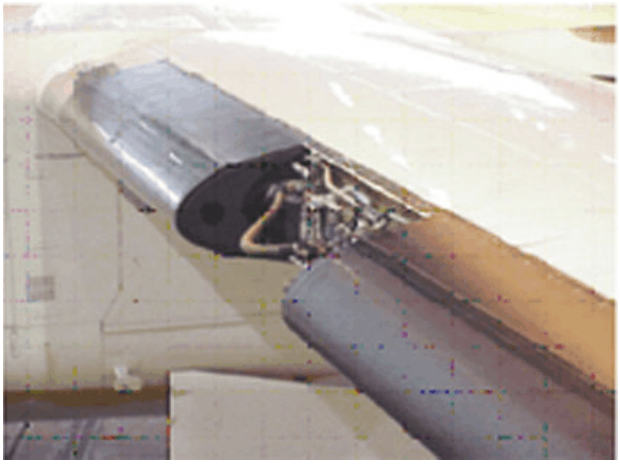

Photo 1. Missing number 4, left, leading-edge panel

The aircraft was parked on the East Satellite Terminal ramp. Flood lights illuminated most of the ramp area, but they also created dark shadows under the aircraft wings. The first officer required a flashlight to inspect the aircraft; the inspection of the aircraft, including an examination of both wings, revealed no anomalies.

Maintenance History

Two days before the occurrence, on 22 October 2002 at 0600, the day-shift maintenance crew began their shift. The position of hanger crew chief is not a permanent position, but is decided daily by seniority. A senior aircraft maintenance engineer (AME) accepted the position of crew chief for that day. Although the responsibilities of the crew chief are not well documented and no formal training is provided, the general understanding is that the crew chief is the liaison between the maintenance supervisor and the crew and is responsible for assigning and supervising the crew's work. In this instance, the crew chief's maintenance expertise was avionics, and there was a regional jet aircraft in the hanger with an avionics snag. The crew chief was working on this snag while carrying out his crew chief duties.

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

At 0600, C–FACF was outside the hanger with a nosewheel steering snag. This snag was expected to be rectified quickly, so C–FACF was parked at the front of the hanger where it could be taken out with minimum disruption to hangar operations. After trouble shooting the snag, it was decided that both nose wheels would be replaced.

While the crew chief was trouble shooting the avionics snag on the regional jet, maintenance control assigned an additional work package to C–FACF that included both a line check and an Out of Phase–3 (OPT–3) check. This work package was brought to the hanger floor by the maintenance supervisor and handed directly to the maintenance crew. One of the junior AMEs (AME 1), who had been a licenced AME for three months and had been hired by Jazz Air Inc. less than one month prior to the occurrence, was tasked with showing some of the most recently hired AMEs how to complete the line check. AME 1 had minimal experience on DHC8 maintenance and did not hold a company Aircraft Certification Authority (ACA). It was left to the crew to determine among themselves who would be responsible for each task on the OPT–3 check. The crew chief was not involved in the work assignments, but he was subsequently informed by the maintenance supervisor of the work package that had been handed out.

The OPT–3 check consists of 11 individual tasks. One of these was task 3010/08, Operational Check of Pneumatic Equipment Heating System, which is a functional check of the electric heaters in the de-ice system. AME 1 volunteered for this task, although he had no previous related experience.

There are 11 steps on the de Havilland Inc. Dash 8 Maintenance Task Card to complete task 3010/08, which include removing the access panels, checking the six cockpit-controlled heaters, checking the seven thermostatically controlled heaters and reinstalling the access panels. There is provision on the task card for two signatures: one from the mechanic who did the job and one from the inspector who confirmed the job was completed. However, on the Transport Canada approved Air Canada Regional Task Card, task 3010/08 has been simplified to a single line on the OPT–3 check. It requires only the initials of the individual who did the inspection. The entire OPT–3 task card, when complete, requires a single signature by an AME who holds a company ACA. Jazz Air Inc. uses the Air Canada Regional Task Card.

AME 1 was briefed by the crew chief and reviewed the maintenance instructions before he started task 3010/08. He set up a work stand to get up to wing level, approximately 12 feet above the floor, then removed the screws from the number 4 leading-edge panel of the right wing. When the screws were removed, the leading edge was still secured by Product Research and Chemical Corporation (PRC®) sealant. Without completing work on the right wing, because he was unsure of how to complete the removal of the leading edge, AME 1 moved the work stand and tools to the left wing and started removing the screws for the left, number 4, leading-edge panel. The right wing was not marked or flagged to indicate that the screws had been removed and that the work was incomplete.

At approximately 1700, AME 1 received voluntary help from an apprentice AME who was working on the afternoon shift and who had previously worked on a task 3010/08. He informed AME 1 that the PRC® sealant had to be cut to release the leading edge and, if the sealant was cut cleanly, it could be resealed later. AME 1 cut the sealant on the top surface of the left wing leading edge, but not cleanly; the apprentice AME then demonstrated how to do it on the bottom surface. They were then joined by another AME (AME 2), who had been hired a week before. AME 2 had not been assigned to a specific task, but he volunteered to assist. AME 2 was

experienced on other turbo prop and turbo jet aircraft but not on the DHC8 aircraft and he did not have the company ACA. Together, they removed the left leading edge and performed the heater checks on the left wing. AME 2 then left to get some replacement PRC® sealant and returned as AME 1 finished re-installing the screws that secure the top of the leading-edge panel to the wing. AME 2 and the apprentice AME then began applying the sealant to the top surface of the left wing leading-edge panel, and AME 1 left to check the heaters in the tail of the aircraft before the end of his shift.

The apprentice AME and AME 2 were still applying sealant to the top surface of the leading edge when AME 1 returned. He gave the apprentice AME the screws for the right wing leading edge and informed him the tail heaters were functional. Since the right wing heaters had not been tested, AME 1 did not sign that task 3010/08 was complete. AME 1 then left for the day. The screws had not been installed on the left wing leading-edge panel, and it had not been sealed.

The apprentice AME and AME 2 moved the work stand to the right wing to complete that part of the job. As they finished cutting the sealant on the right wing leading-edge panel, the maintenance supervisor called the apprentice AME away from the aircraft to send him to the ramp. The apprentice AME repositioned the right wing leading edge and installed one screw so the leading edge would not fall. He then put the remaining screws in a latex glove, taped it to the leading-edge section and left for the ramp. AME 2 also left, as his day shift was over.

When the crew chief reviewed the work sheets before going home at 1800, he noted that task 3010/08 had not been signed out. He had previously talked with AME 1 and believed that he had checked all 13 heaters. The crew chief initialled task 3010/08 as being complete, even though some tasks had not been completed, because he did not want the night crew to have to recheck all 13 heaters.

The night shift crew arrived at 1930. After reviewing the aircraft paper work, they determined that, although task 3010/08 had been signed off, the work was not complete. As well, the aircraft still needed an engine run to functionally check the de-ice boot operation, and the aircraft needed a taxi test to complete the rectification of the nosewheel steering snag. One of the night shift AMEs (AME 3) met with the apprentice AME for a status report on task 3010/08 when he returned to the hanger for his lunch break at 2000. His report was that the left wing was complete but the right wing was not. Two AMEs from the night shift crew examined the number 4 leading-edge panel on the right wing and installed the remaining screws. The aircraft was then functionally checked, signed out and parked outside of the hanger as a hot spare. At this time, there were no screws in the bottom of the left wing leading-edge segment, it had not been sealed and the heating elements in the right wing leading edge had not been checked.

Photo 2. Cross-section of the left leading edge

The aircraft sat all day Wednesday and Thursday, until Thursday night when it was assigned to Flight 7956. No work card had been generated to seal either the bottom of the left wing leading-edge section or the right wing leading-edge section. The missing screws from the bottom of the left wing leading edge were not located.

The number 4 leading-edge panel is approximately 38 inches long, D shaped, with 11 inches between the top and bottom rows of screws. The leading-edge panel is painted black and has a black pneumatic de-ice boot across the leading edge. It is secured to the wing structure by 14 brass-coloured, countersunk screws on the top, and another 14 on the bottom. Although there is some paint in the countersunk recess of the leading edge, most of the screw holes have a significant amount of bare aluminium showing. All of the screws securing all of the leading-edge sections are unpainted.

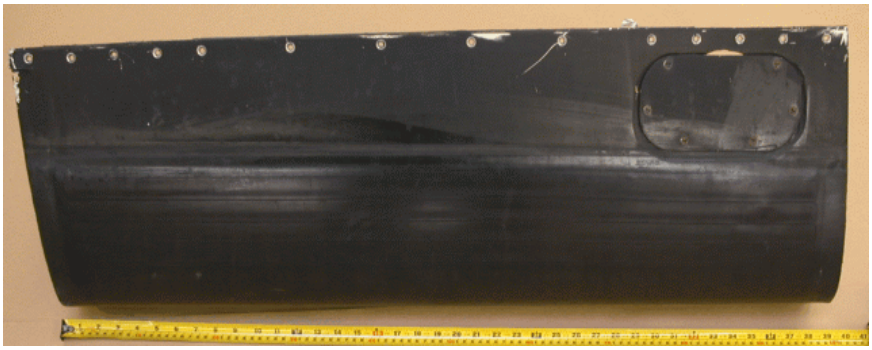

Photo 3. Left leading-edge section

Other Occurrences

On 04 January 1998, a de Havilland DHC8–100, registration N881CC, operated by CCAir, Inc., lost the number 1 right-hand leading edge on departure from Charlotte, North Carolina. The leading-edge panel had been removed for maintenance and the bottom screws had not been re-installed. The flight crew was able to land the aircraft without further incident.[2]

On 11 September 1991, an Embraer 120, operated by Continental Express, lost the leading edge of the left horizontal stabilizer over Eagle Lake, Texas. The loss of the stabilizer leading edge resulted in an in-flight breakup of the aircraft and the loss of 14 lives. Forty-seven screws had not been installed, as required, in the top surface of the leading-edge panel.[3]

Analysis

Task 3010/08 was not a complex job: there were no pressing time constraints, and complete manufacturer's instructions on how to locate, access and test the relevant components were available to the AMEs involved. Therefore, this analysis will focus on the human factors that led to the aircraft being dispatched with an unsecured leading edge and without the heating elements in the right wing leading edge being inspected.

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2 Federal Aviation Administration, National Aviation Safety Data Analysis Centre, Report 19980104001979C.

3 National Transportation Safety Board, Report AAR–92–04.

AME 1

AME 1 picked task 3010/08 because he was unfamiliar with the task and he wanted the experience. He took the extra time to check with the crew chief and to check the maintenance instructions before beginning the job. As he had not done this job before, it took him longer than normal to complete it, and he felt rushed when it was obvious that the task would not be completed before the end of his shift. By the time he finished installing the screws on the top of the wing leading edge, AME 2 was ready with the sealant. There was no discussion about sealing the top of the leading edge before installing the bottom screws, but it was convenient to do so. While the apprentice AME and AME 2 were applying the sealant, AME 1 went to check the rear fuselage heaters. By the time he returned, he had forgotten about the screws for the bottom of the leading edge, the apprentice AME and AME 2 were finishing sealing the top of the panel, and he handed over the screws that he had accumulated in his pocket. This turned out to be the appropriate number of screws for the right wing leading edge.

AME 1's handover briefing to the crew chief was verbal and informal. It was limited to relaying that the heaters in the left wing and tail were functional, that AME 2 and the apprentice AME would finish checking the right wing, and he (AME 1) had not signed the task as being complete. There was no discussion about who would ultimately sign for task 3010/08 when it was completed.

Apprentice AME

The apprentice AME had not been assigned to work on the aircraft but volunteered to help. One consequence of coming into the middle of the job was that he did not take ownership of the job. He assisted AME 1 to remove the leading edge, and he continued to assist by supporting the leading-edge section while AME 1 performed the heater tests. He spent much of the time on the lift in unrelated conversation with AME 2. The only part of the job that he took ownership of was when he took the initiative to seal the top of the wing leading edge. He felt that this was required because the existing sealant had not been cut cleanly, but from the outset, he had no intention of sealing the bottom of the wing leading edge. The screws for the bottom of the leading edge had not been set aside in an obvious location; therefore, there was no reminder that the bottom of the leading edge had not been secured. He did not check the work completed by AME 1. When he completed the sealing of the top of the wing, he began to move the stand and tools to the right wing.

Before the apprentice AME was able to do much more than cut the sealant on the right wing leading edge, he was re-tasked to the ramp. There was nothing more than a verbal turnover to the maintenance supervisor, indicating that the work on the right wing had not been completed. It was two hours later when the apprentice AME returned to the hanger for a lunch break and he was asked by AME 3 about the status of task 3010/08. His verbal briefing, done while he was walking to the lunch room, was limited to relaying that except for the right wing, everything about task 3010/08 had been completed. He did not elaborate about checking the heaters in the right wing, nor was he asked about it.

AME 2

AME 2 was the most experienced AME of those directly involved in replacing the left wing leading-edge panel; however, he had the least amount of time with the company. AME 2 was not assigned to task 3010/08; he volunteered to help. He assisted by obtaining and helping to apply the sealant, but he did not take an ownership role in any part of the project. During a significant period of time, the three involved AMEs were engaged in conversation unrelated to task 3010/08. AME 2 was not concerned that they were not sealing the bottom of the leading-edge panel, nor did he did check the status of the bottom of the leading-edge panel.

Crew Chief

The position of crew chief was reassigned daily based on seniority. It was not often offered to this individual because he had only eight months with the company. The specific duties and responsibilities had not been communicated to the crew chief, nor had he received any training for this job. Although he had not anticipated being appointed to the position that day, he assumed responsibility for the work done by the crew. Instead of accepting this as a new job with new responsibilities, he added these new responsibilities to those that he had already. Therefore, he was trying to do two jobs simultaneously: maintaining the aircraft and supervising a crew of AMEs. The crew chief's job and authority were undercut by the maintenance supervisor when he issued the work package directly to the crew rather than to the crew chief. This meant that the crew chief had no input into the assignment of individual tasks to the AMEs, making it difficult for the crew chief to supervise the work as it progressed.

The crew chief had initially discussed task 3010/08 with AME 1, after which he did not directly supervise AME 1. This was not uncommon, as the task was not complex. He was aware that AME 2 had picked up the PRC® sealant for the left wing, and it was logical for him to assume that the sealant would be applied to both the top and bottom of the leading edge. He also noted that the apprentice AME and AME 2 had moved to the right wing, presumably to complete the task on the right wing. At the end of the shift, the crew chief was reviewing the paper work and realized that task 3010/08 had not been signed off. He believed that AME 1 had completed testing all of the heaters, and all that remained of the task was to reinstall and reseal the right leading-edge section. To make sure that the evening crew did not go back and recheck all the heaters, he signed the task as being complete, knowing that work on the right wing leading edge was not complete.

AME 3

When AME 3 arrived on the night shift, he noted that task 3010/08 had been signed as having been completed; however, he received a limited verbal briefing from the apprentice AME, who informed him that the right wing portion of task 3010/08 had not been completed. AME 3 completed the leading-edge panel installation then took the aircraft out for its engine run up and taxi test. He did not inspect the heater operation, nor did he raise a task card to reseal the leading edges. Prior to the taxi test, AME 3 conducted a walk-around inspection of the aircraft but did not notice that screws were missing from the bottom of the left wing. After completing the taxi test, he released the aircraft to service and parked it outside the hanger as a spare, ready to go.

Company Management

The OPT–3 work package is an Air Canada regional amalgamation of 11 independent maintenance tasks. Each task was originally designed by the aircraft manufacturer, and each task card required two signatures. These maintenance tasks are not identified in *Canadian Aviation Regulations* as legally requiring an independent inspection, and in amalgamating the tasks into a single line on the OPT–3 task card, the company dropped the requirement for the inspector's signature. An inadvertent consequence of this change was that one opportunity to identify that the leading-edge screws were missing before the aircraft went flying was lost.

Both the apprentice AME and AME 3 deferred sealing the leading-edge panel, although there was no provision on the OPT–3 task card to report this fact, and no work card was generated to indicate the leading edges had not been sealed. The lack of communication between all of the individuals involved, particularly at the shift turnover point, contributed to this. The company did not have a specific procedure for communicating the status of work at the shift turnover.

Communications with Flight Crew

The only communication available to the flight crew regarding the maintenance work that had been completed on the aircraft was the log book entry regarding work package #446. This did not provide the crew with any indication of the type or scope of the work accomplished other than the L-check, which was a familiar, recurrent, 75-hour inspection. The information in the log book entry did not provide the flight crew with any particular focus area for their pre-flight inspection.

No Visual Cues

The unpainted, brass-coloured screws that hold the leading-edge sections in place are highly contrasted by the black paint and pneumatic boot on the leading edges. All of the leading-edge screw holes are countersunk, and there is little paint remaining on the shoulders of these countersunk holes. The contrast provided by the bare aluminum of the leading-edge structure is similar to that of an unpainted screw. Thus, unless someone, an AME or pilot, is looking specifically for the screws, it would not be obvious that the screws had not been installed.

Findings as to Causes and Contributing Factors

1. The individuals working on the aircraft did not check their own work or the work of others involved in task 3010/08. There were no inspection procedures to assure that the work was complete or that incomplete work that was deferred was properly recorded.

2. Having additional people on site who were not required for the job caused a distraction to those doing the work and led to false assumptions that individuals had completed work that was, in fact, unfinished.

3. There were no processes to ensure that communication between the maintenance manager and the crew chief, between the crew chief and the crew, or between crews, was complete and accurate.

4. The crew chief signed task 3010/08 as being complete based on his assumption that all the heaters had been checked but knowing that the leading-edge panel was not installed. There were no procedures for AME 1 to sign for the portions of task 3010/08 that were complete, or to indicate which portions of the task were incomplete.

Findings as to Risk

1. There was no supervisory training provided for the position of crew chief.

2. When AME 1 left the right wing after removing the screws, he took the screws with him and did not mark the area as having been partially disassembled. There were no procedures in place to indicate where relevant parts were located, or to ensure that incomplete work was recorded, identified or flagged.

Safety Action Taken

Jazz Air Inc. conducted an internal investigation into this occurrence using a Maintenance Error Decision Aid process. This process identified a number of deficiencies, and the company modified its procedures to improve the quality of the work and to reduce the chance of a maintenance error going undetected.

Jazz Air Inc. added a general maintenance procedure (GMP) to Section 1 of its *Maintenance Procedures Manual*, requiring an independent visual inspection of the leading-edge installation. GMP number 14 states:

> Independent and Required Inspections are Standards of Airworthiness and shall be conducted under the guidelines of this procedure for any maintenance action carried out on Air Canada Jazz aircraft that requires such an inspection.

Jazz Air Inc. has added a line maintenance procedure (LMP) to Section 2 of its *Maintenance Procedures Manual*, specifying the procedure to be followed for passing information from the departing maintenance crew to the incoming maintenance crew. LMP number 10 states:

> To prevent inadvertent dispatch of an aircraft with incomplete maintenance tasks, and to provide a basic minimum standard to record and control outstanding work – Whenever work is in progress and a change in manpower occurs, a concise list of open tasks must be readily available and understood by the incoming shift personnel. This is not limited to shift changes, as during the course of a shift, personnel may have to leave the work in progress for any reason, i.e. AOG assignments, holding for parts, sickness, etc.

The Jazz Air Inc. maintenance base at Toronto had expanded rapidly just prior to this occurrence, and the ratio of experienced to inexperienced AMEs was undesirably low. The company is targeting a ratio of 80 percent experienced AMEs. At the same time, Jazz Air Inc. has increased training for new employees on "Human Performance in Maintenance" and will attempt a phased-in approach to hiring for anticipated future expansion.

The company has produced a pocket-sized, quick reference handbook to aid AMEs in their assigned work.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 02 March 2005.

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