

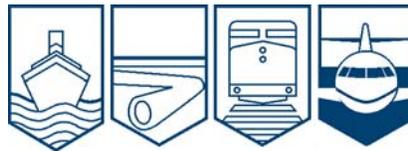
Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A04P0397



RISK OF COLLISION

NAV CANADA
VANCOUVER INTERNATIONAL AIRPORT,
BRITISH COLUMBIA
29 OCTOBER 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

On 29 October 2004, at 0653 Pacific daylight time (before daylight), a Britten Norman BN2P Islander (Navair 612) was holding in position at the threshold of Runway 08R awaiting take-off clearance. While Navair 612 was holding, a de Havilland DHC-8 (Jazz 8191) was instructed to taxi to position on Runway 08R behind the Islander. When issuing this instruction, the controller thought that Jazz 8191 was on Taxiway L at the threshold of Runway 08R, when Jazz 8191 was actually on Taxiway L2, farther down the runway, ahead of Navair 612. The controller then cleared Navair 612 for take-off on Runway 08R as Jazz 8191 was taxiing to position on that runway from Taxiway L2. A high-speed collision nearly occurred when Navair 612, during rotation for lift-off, passed by Jazz 8191.

Ce rapport est également disponible en français.

Other Factual Information

The weather at Vancouver International Airport at 0600 Pacific daylight time¹ was as follows: wind 110° True (T) at 10 knots, clouds scattered at 800 feet above ground level (agl), broken at 2500 feet agl, broken at 5000 feet agl, visibility 3 statute miles, temperature 7°C, dew point 6°C, altimeter setting 30.14 inches of mercury.

The relevant air traffic control (ATC) positions were: clearance delivery, south ground and south tower. On the morning of the occurrence, the clearance delivery and south ground control positions were staffed by one controller.

When the south ground controller was issuing taxi instructions to Jazz 8191, the crew was asked if they would like to use Taxiway L2 or the end of the runway; the crew responded "Lima 2." They taxied to L2 and held short of Runway 08R awaiting further instructions or take-off clearance.

At the time of the occurrence, two arriving aircraft were on final for Runway 08R, and seven aircraft were waiting to depart on Runway 08R (see Appendix A – Aircraft Positions). Aircraft departing on Runway 08R can approach the threshold from either Taxiway A on the south side of the runway, or Taxiway L on the north side. Jazz 8191, one of the waiting aircraft, was on Taxiway L2, on the north side farther down the runway. Of the other six aircraft, four were on Taxiway L (a DHC-8, two Islanders, another DHC-8) and two were across the runway on Taxiway A (the Islander [Navair 612] and a Mitsubishi MU-2).

After the first DHC-8 on Taxiway L departed, the first arriving aircraft landed. The south tower controller then cleared Navair 612 to position (from Taxiway A at the threshold) and requested that the pilot move ahead to permit a DHC-8 to line up behind. Jazz 8191 was then cleared to position behind the Islander.

The crew of Jazz 8191 did not see the Islander ahead of them and could not see the threshold because of the angle of the taxiway they were on. The south tower controller did not state the runway entry position because he thought that Jazz 8191 was at the runway threshold. Controllers are required to issue the name of the runway intersection or taxiway with the authorization only if the position being taxied to is not at the threshold of the departure runway. Pilots are not required to state or to read back the runway entry location.

The controller had arrived for his fifth day shift at approximately 0620. He conducted a self-review of the daily unit log, operations directives and NOTAMs (Notices to Airmen). Some taxiway closures were in effect on the airfield, but none affected aircraft taxiing for departure on Runway 08R. The controller had worked two night shifts some two weeks before the occurrence, and at that time, Taxiway L2 had been closed. The south tower controller being relieved conducted a hand-over briefing, and the change of control of the south tower position occurred at 0630.

¹ All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

The airport is served by airport surface detection equipment (ASDE), a short-range radar system that detects primary targets on the airfield, and airborne targets below 200 feet and within one nautical mile of the airport. The system displays secondary surveillance targets and associated data tags for aircraft using a transponder, if the appropriate information is entered into the computer system, normally through a flight plan.

Because departing flights normally do not switch their transponders on until cleared for take-off, they appear only as unidentified primary targets. The ASDE system at Vancouver International Airport is known to randomly display erroneous information. It is common for false targets to appear and for real targets to disappear. Data tags assigned to provide identification can disappear or swap between two targets that pass in close proximity. Occasionally, signage or barricades on the airfields show up as targets.

Because of these unresolved problems, the ASDE system at Vancouver International Airport is not used as a sole reference tool, but only as an aid. In this occurrence, the controller did not rely on the ASDE and did not refer to it consistently. At the time of the occurrence, a target was displayed on Taxiway L2. However, because of the known ASDE problems, the south tower controller did not think that the target was an aircraft. The controller did not verify the target with the available binoculars, radio communications, or the south ground controller at the adjacent workstation. When Jazz 8191 was cleared to position behind the Islander (which was at the threshold), the controller did not note that the target was moving onto the runway at Taxiway L2.

To aid in indicating closures on the airfield, controllers commonly electronically insert solid-coloured blocks on the ASDE monitor to obscure closed portions of the field. No closures were indicated in this manner for the taxiways involved in this occurrence. During the pre-shift self-review and subsequent transfer of position responsibility briefing by the controller being relieved, no information was presented to the incoming south tower controller to indicate that Taxiway L2 was closed.

Diminished capability of the human eye at night adversely affects the ability of pilots and controllers to see unlit objects, to identify the location and the motion of objects on the ground or in the air, to judge distances between objects, and, therefore, to maintain good situational awareness based on visual inputs alone.² The sole pilot of Navair 612 did not see the DHC-8 entering the runway at Taxiway L2 until he was passing by it when rotating for lift-off. The threshold of Runway 08R is more than one nautical mile from the control tower, further increasing the difficulty for a controller to identify individual aircraft at the threshold.

Aircraft departing Vancouver International Airport make their first contact with ATC on the clearance delivery frequency. There was a concern that forecast weather conditions may restrict the departures of some aircraft, so each flight was requested to provide its authorized departure weather minima. That information was recorded by hand on each flight progress strip.

²

On the flight progress strip for Jazz 8191, the handwritten entry for departure weather encroached on the box designated for the taxi route instructions. Subsequently, Jazz 8191 contacted south ground control for taxiing instructions and was assigned Taxiway L2. The taxiway designator "L2" was written in the appropriate box; however, it was displaced and the digit "2" was partially obscured. The south tower controller retrieved that flight progress strip from the board between the clearance delivery/south ground position and the south tower position and placed it in sequence in a top-to-bottom order at the work position of the south tower controller. The controller's scan of the flight progress strips for the four remaining departures from the north side of the runway did not detect that Jazz 8191 was assigned Taxiway L2, whereas the rest were assigned Taxiway L.

During hours of darkness, interior lighting levels in the tower are subdued to allow for visual observation of the airfield. A brief random survey of controllers indicated that they found the lighting levels to be adequate to read the flight progress strips effectively.

When Jazz 8191 was instructed to taxi to position behind the Islander (Navair 612), the Jazz flight crew apparently acknowledged the instruction; however, their acknowledgement was blocked by another transmission from an unidentified source. The acknowledgement did not appear to challenge the south tower controller's instruction regarding the missing taxiway location required for an intersection departure.

The south tower controller queried as to who had made the last call, and a transmission came from an unidentified source indicating that they were "the DHC-8 behind the Islander," followed by some comments about the Islander's navigation lights not being illuminated. Several transmissions followed from unidentified sources regarding navigation lights on Islanders.

Although proper radio telephony procedures are well documented, the use of non-standard radio procedures prevailed among the group of pilots participating in the navigation light discussion. During this time, the south tower controller cleared Navair 612 for take-off from Runway 08R.

At the time that Navair 612 was starting its take-off roll, Jazz 8191 was moving toward the runway on Taxiway L2. The pilots of Jazz 8191 were looking farther down the runway, toward the mid-field area, for the Islander that they were instructed to follow. Taxiway L2 is a high-speed exit for the reciprocal Runway 26L, and this angle makes it difficult for a crew to view Runway 08R (over their right shoulder) toward the threshold. As the aircraft was proceeding onto the runway, the crew became uneasy and decided to turn to their right to view the runway toward the threshold. At that time, they saw the landing lights of Navair 612 coming down the runway on the take-off run. The crew stopped the aircraft and switched on all exterior lights as Navair 612 rotated for lift-off in front of them.

It is likely that, before the take-off clearance for Navair 612, all six remaining departures were able to monitor the south tower control frequency. Most, if not all, of the flight crews waiting to depart operate out of Vancouver International Airport regularly and would have been familiar with other local operators and aircraft types. No one drew attention to the fact that, when Jazz 8191 was instructed to take position behind Navair 612, no Jazz aircraft was in a position to comply with that instruction.

On 25 October 2000, a runway incursion event with many similarities occurred at night at Vancouver International Airport on Runway 26L (the reciprocal of Runway 08R). The TSB investigation (report A00P0206) found that, of two aircraft on the runway, both accepted and simultaneously read back a take-off clearance that had been directed to one, and that the clearance had not included the taxiway intersection. As a result of that occurrence and of previous occurrences, NAV CANADA adopted a procedure that has become a requirement in the *Air Traffic Control Manual of Operations (ATC MANOPS)*; for take-offs other than from the threshold, controllers are to include the taxiway or runway intersection with the take-off clearance. This information is also reflected in Section RAC 4.2.5 of the *Aeronautical Information Manual (AIM)*.

The National Civil Aviation Safety Committee formed a Sub-Committee on Runway Incursions (SCRI) in response to an increase in occurrences of this nature. The SCRI completed two studies and made several recommendations to minimize the risk of runway incursions. The issue of intersection departures was identified in Recommendation 4.7 of the SCRI, published in September 2000, which recommended that Transport Canada and NAV CANADA collaborate to develop a policy regarding intersection departures. Although discussions were held, no policies regarding intersection departures were developed. Consequently, flight crews are currently not required to include the taxiway or runway intersection with clearance onto a runway.

The SCRI agreed to a recommendation to amend the training standards in the *Commercial Air Service Standards (CASS)* to include a regulatory requirement for communication training. Notices of Proposed Amendment (NPAs) to the standards were proposed, and agreed to, at the June 2003 Commercial Air Service Operations (CASO) Technical Committee meeting, but are awaiting legal editing and promulgation. The proposals included additional emphasis on International Civil Aviation Organization (ICAO) standard phraseology, and on the need to minimize unnecessary cockpit tasks under the communication and taxiing paragraphs respectively.

Analysis

Except for the known deficiencies with the ASDE in the tower, no equipment failure issues were involved in this occurrence. However, the procedures that were in place did not prevent the controller from losing track of aircraft positioning. Furthermore, the remaining defences did not provide sufficient backup after the controller mistakenly assumed that Jazz 8191 was behind Navair 612.

The factors that led to the controller making an incorrect assumption about the position of Jazz 8191 were as follows:

- Taxiway L2 had been closed during the south tower controller's previous night shift. The controller did not register that Taxiway L2 was open even though it was not blocked out on the ASDE monitor at his workstation to indicate that it was closed, and despite his daily pre-shift review on the day of the occurrence and during the previous four day shifts.

- When the south tower controller observed an ASDE target at Taxiway L2, he assumed the target to be false because of the previously noted unreliability of the ASDE equipment.
- The south tower controller did not verify the target at Taxiway L2 with the available binoculars, radio communications, or the south ground controller.
- The displaced and partially obscured taxiway assignment, L2, on the flight progress strip for Jazz 8191 resulted in the south tower controller missing the digit “2” when he scanned down the column of flight progress strips.

Even though multiple defences may apply to one party, if that party is a party of one and an error is introduced, biases³ may prevent recognition and acceptance of information that is contrary to the party’s mental model or mindset of the current situation. In this occurrence, the south tower controller’s plan was based on false information, and, although cues to the contrary were present, those cues did not cause the south tower controller to re-evaluate the situation.

Defences, common to two or more parties, were also in place to prevent such runway incursions:

- Neither the south tower controller nor the pilots of either aircraft on the runway stated runway locations. When clearing an aircraft onto a runway from a position other than the threshold, controllers are required to state the runway entry location. A runway entry location was not communicated to Jazz 8191 because the south tower controller believed that Jazz 8191 was at the threshold. In this instance, there may have been an obligation for the flight crew of Jazz 8191 to query the south tower controller because they could not see the Navair Islander that they had been cleared to position behind, and because their clearance did not mention the intersection entry point (as stated in the AIM). The runway entry location for Navair 612 was not stated, nor was it required at the threshold. The lack of a communicated runway entry location for Navair 612 did not necessarily create an expectation for the crew of Jazz 8191 that the Islander was at the threshold behind them. The circumstances of this occurrence demonstrate that the safety action taken by NAV CANADA in response to TSB investigation A00P0206 fell short of being complete because it did not establish a requirement for tower controllers to also state runway entry locations at the threshold when intersection departure procedures are being used. Furthermore, pilots are not required to state the position at which they will enter a runway or commence their take-off roll. These shortfalls continue to contribute to confusion and erroneous assumptions. The result is a continuing risk of collision from runway incursions when intersection departure procedures are being used.

³ **Bias** – the tendency to apply a certain response regardless of the situation
Salience bias – the tendency to focus on physically important evidence and ignore critical cues that might provide diagnostic information about the nature of a problem
Confirmation bias – the tendency to seek information that will confirm what we already believe to be true. Information that is inconsistent with the chosen hypothesis is then ignored or discounted (Transportation Safety Board of Canada, *An Integrated Process for Investigating Human Factors*)

- It has long been argued that a common frequency and common phraseology act as a safety defence by promoting a heightened level of situational awareness among all users. However, the chance of identifying and correcting an error, through the use of radio protocols, is also directly dependent on the rigour with which those protocols are applied. During the communication exchange regarding the navigation lights on an Islander, the unidentified transmission from “the DHC-8 behind the Islander” reinforced the south tower controller’s perception that events were being executed in accordance with his plan, when, in fact, they were not.
- The use of proper call signs could have alerted the south tower controller that “the DHC-8 behind the Islander” was not Jazz 8191. Of six flight crews in a position to monitor the south tower control frequency, many of which were two-pilot operations, no one queried the south tower controller about the location of the DHC-8 (Jazz 8191) that was instructed to line up behind the Islander. This factor may indicate that no one really had an accurate awareness of the situation and confusion therefore prevailed.
- There were no weather-related obstructions to visibility on the airfield, and yet the sole pilot of Navair 612 did not see the DHC-8 until passing by it during rotation for lift-off. A take-off clearance indicates to a pilot that the runway surface is clear of traffic and safe for the intended operation; therefore, a pilot would not expect to see an aircraft on the runway ahead. The south tower controller’s focus on planning ahead for several departures and other potential workload distractions likely made it more difficult for the south tower controller to detect, by visual means alone, that Jazz 8191 had moved onto the runway (unexpectedly from the controller’s perspective) at Taxiway L2. It is reasonable to conclude that darkness, distance, airport and aircraft lighting, and the angle of approach to the runway for Jazz 8191 adversely affected the ability of the flight crews and tower controller to clearly “see” the correct traffic model. Much has also been written about the limitations of the human eye regarding unalerted see-and-avoid in mid-air collisions and air proximity events. These same limitations may have played a role in this occurrence.

The risk of a runway incursion is increased when aircraft approach the active runway from positions other than the threshold, rather than in a single line at the threshold. Once an error (unexpected event) occurs, compounded by adverse visibility, the chance of the error being noticed is reduced. Because flight crews are not required to include the taxiway or runway intersection with clearance onto a runway and because tower controllers are not required to include the entry point in clearances at the threshold, risk in the runway environment is increased during intersection departure operations, especially at night or during low-visibility operations.

Findings as to Causes and Contributing Factors

1. When Navair 612, at the threshold of Runway 08R, received the clearance for take-off, the runway was unsafe for the intended operation because another aircraft, Jazz 8191, was taxiing, in accordance with air traffic control (ATC) instructions, to position on the same runway. Unbeknownst to the crew of either aircraft on the runway or to the south tower controller, Jazz 8191 was in front of Navair 612, rather than behind, as assumed.
2. Cues to contradict the south tower controller's assumption that Taxiway L2 was closed were present, but those cues did not cause the controller to re-evaluate the situation.
3. The south tower controller did not use the binoculars, radio communications, or the south ground controller at the adjacent workstation to verify the airport surface detection equipment (ASDE) target displayed at Taxiway L2.
4. The taxiway assignment, L2, was displaced and partially obscured on the flight progress strip for Jazz 8191. The digit "2" was not detected when the south tower controller scanned down the column of flight progress strips.
5. The instruction for Jazz 8191 to taxi to position on Runway 08R did not include the taxiway designator, as would be required for an intersection departure. This missing segment of the instruction was not questioned by the flight crew, and an opportunity was missed to alert the south tower controller that his plan was not being executed as intended.
6. A series of unidentified radio transmissions occurred regarding inoperative navigation lights on an Islander, creating some confusion. Some of these transmissions reinforced the south tower controller's belief that his plan was being executed as intended when, in fact, it was not.

Findings as to Risk

1. Neither the south tower controller nor the pilots of either aircraft on the runway stated runway locations. These shortfalls continue to contribute to confusion and erroneous assumptions, with a continuing risk of collision from runway incursions being the result.
2. Tower controllers are not required to include the entry point in clearances onto the runway at the threshold and flight crews are not required to indicate the taxiway or runway intersection entry point onto a runway. Therefore, the risk of a runway incursion error is increased during intersection departure operations, especially at night or during low-visibility operations.

3. The ASDE system at Vancouver International Airport has been known to randomly display erroneous information, which places an additional workload upon controllers to verify airfield traffic by other means.

Other Findings

1. As Jazz 8191 was proceeding onto the runway, the crew became uneasy and decided to stop and turn to their right to view the runway toward the threshold. This single action was the last remaining defence against a collision on the runway.

Safety Action Taken

The Vancouver International Airport tower manager issued an Operations Bulletin on 04 November 2004 to remind controllers to adhere to the *Air Traffic Control Manual of Operations* (ATC MANOPS) direction to state the name of the intersection or taxiway when issuing taxi to position instructions or take-off clearances from an intersection. Controllers were also encouraged to specify the threshold used if more than one aircraft was being taxied to position. The Vancouver Control Tower Operations Committee conducted a review of the Operations Bulletin before its expiry date and a decision was made to let it expire without implementing any new procedure.

The Vancouver International Airport tower manager issued direction to tower staff to document any anomalies detected with the operation of the airport surface detection equipment (ASDE) system.

The Vancouver International Airport tower manager issued direction to staff to enter non-control-related information on flight progress strips in a box more appropriate than the taxiway designator box.

NAV CANADA has proposed an amendment to Section RAC 4.2.8 of the *Aeronautical Information Manual* (AIM), which would recommend that pilots include their location with the runway number when requesting take-off clearance.

Safety Concern

Although proposals have been made by Transport Canada and NAV CANADA to change the phraseology requirements regarding runway entry clearances for Air Traffic Services personnel and aircrew, the Board is concerned that a residual risk of collision remains until these proposals are implemented.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 07 June 2006.

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Appendix A – Aircraft Positions

