

Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

**AVIATION INVESTIGATION REPORT
A13H0003**



RUNWAY INCURSION AND RISK OF COLLISION

**NAV CANADA
OTTAWA CONTROL TOWER
OTTAWA/MACDONALD-CARTIER INTERNATIONAL
AIRPORT
OTTAWA, ONTARIO
01 DECEMBER 2013**

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 A13H0003

Runway incursion and risk of collision

NAV CANADA

Ottawa Control Tower

Ottawa/Macdonald-Cartier International Airport

Ottawa, Ontario

01 December 2013

Summary

On 01 December 2013, at 1916 Eastern Standard Time, during the hours of darkness, a Piaggio P-180 (registration C-GFOX, serial number 1065), with 2 crew on board, was authorized to taxi across Runway 14 on its way to Runway 07 at the Ottawa/Macdonald-Cartier International Airport, Ontario. Shortly thereafter, a second aircraft, a de Havilland DHC-8-311 (registration C-GEWQ, serial number 202) operating as Jazz (JZA) 988, a scheduled passenger flight to Montréal/Pierre Elliott Trudeau International Airport, Quebec, with 3 crew and 15 passengers on board, was taxiing from the de-icing pad to Runway 14 for takeoff. At 1919, JZA988 was cleared for departure and began its take-off roll. At 1920, C-GFOX crossed Runway 14, approximately 4400 feet in front of JZA988. Neither aircraft was aware of the runway incursion and continued their flight without further incident.

Le présent rapport est également disponible en français.

Factual information

History of the flight

On 01 December 2013, Runway 07 at the Ottawa/Macdonald-Cartier International Airport (CYOW), Ontario, was being used for arriving and departing aircraft. Aircraft de-icing operations were in progress, and aircraft leaving the de-icing pad were offered Runway 14 for departure to minimize taxi time.

At 1916¹, the ground controller² issued instructions to C-GFOX to taxi from the Royal Canadian Mounted Police (RCMP) apron to Runway 07 via taxiways G and B, the main apron, Taxiway C and across Runway 14/32 (Appendix A). C-GFOX was instructed to contact the tower once holding short of Runway 07.

At 1917, the ground controller issued instructions to Jazz (JZA) 988 to taxi from the de-icing pad to Runway 14 via taxiways A and L (Appendix A). JZA988 was instructed to contact the tower once holding short of Runway 14, on Taxiway L.

At 1918, coordination between the ground and airport³ controllers was completed for the exchange of responsibility for Runway 14 to allow its use by JZA988, at which point the airport controller took over responsibility for Runway 14.

The airport controller completed a scan of the airport manoeuvring area and the NAV CANADA Extended Computer Display System (EXCDS)⁴. The airport controller saw an aircraft (C-GFOX) approaching Taxiway C; however, as there was no indication on the airport controller's EXCDS display screen that an aircraft was taxiing for a runway, the aircraft on Taxiway C was thought to be taxiing to the de-icing pad.

At 1919:28, JZA988 was cleared for takeoff on Runway 14 from the intersection of Taxiway L. At 1920:00, as C-GFOX entered Runway 14, JZA988 had commenced its take-off roll and was accelerating through a ground speed of approximately 60 knots. At approximately 1920:04,

¹ All times are Eastern Standard Time (Coordinated Universal Time minus 5 hours), unless otherwise stated.

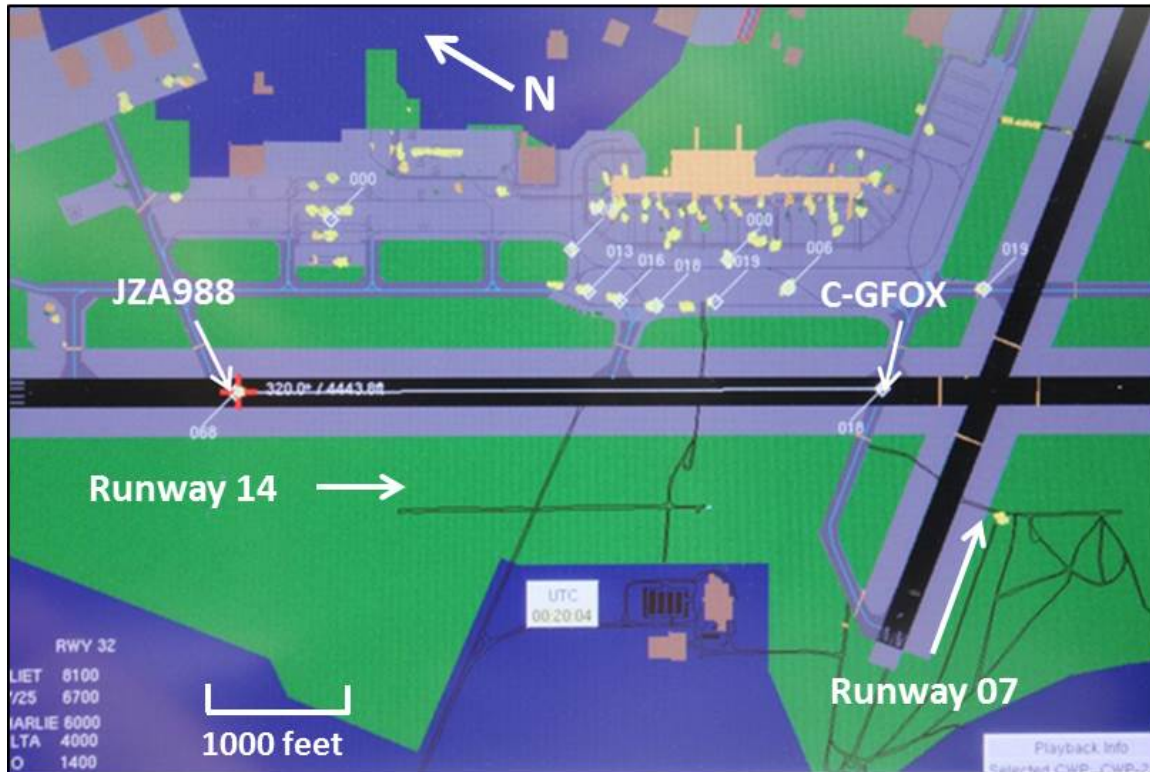
² The ground controller is the duty controller assigned to the ground control position in an airport control tower. (Source: NAV CANADA, *Air Traffic Control Manual of Operations*, Effective: 2013-10-17 to 2014-04-02, Definitions)

³ The airport controller is the duty controller assigned to the airport control position in an airport control tower. (Source: NAV CANADA, *Air Traffic Control Manual of Operations*, Effective: 2013-10-17 to 2014-04-02, Definitions)

⁴ EXCDS is a computer-based coordination system that permits controllers to manage electronic flight data using display screens instead of paper flight progress strips. (Source: NAV CANADA Products, <http://www.navcanatm.ca/en/portfolio/nav-canada-project.aspx> [last accessed on 7 July 2015])

when C-GFOX was near the middle of Runway 14, the horizontal distance between the 2 aircraft was approximately 4400 feet (Figure 1). The ground controller noticed the runway incursion and estimated that C-GFOX would be clear of the runway by the time JZA988 reached the intersection of Taxiway C. Thus, no call was made for JZA988 to abort the takeoff, and the flight continued without further incident, unaware of the runway incursion.

Figure 1. Ottawa/Macdonald-Cartier International Airport ASDE (airport surface detection equipment) display at 0020:04 UTC (1920:04 EST) (Source: NAV CANADA, with TSB annotations)



Weather

The CYOW aviation routine meteorological report (METAR) issued at 1900 was wind 060° magnetic at 6 knots, visibility 2½ statute miles, light snow, scattered clouds at 500 feet above ground level (agl), overcast ceiling at 1500 feet agl, temperature -3°C, dew point -4°C, and altimeter 30.08 inches of mercury.

Air traffic services

Staffing

The airport controller had worked a midnight shift (from 2315 until 0743) on 29 November and had been off duty on 30 November. The ground controller had been off duty from 26 to 29 November and had worked the evening shift (from 1500 until 2328) on 30 November, the day before the occurrence. There was no indication that fatigue was a contributing factor.

Staffing guidelines for the Ottawa tower call for a minimum of 4 controllers to be on duty during the evening shift; however, only 2 controllers were on duty at the time of the occurrence. One controller was working the airport position and the other was working the combined ground and clearance delivery⁵ positions.

At 1500, there were 4 controllers on duty. At 1900, 2 of those controllers left as it was the end of their shift. Four controllers were scheduled to be on duty for the evening shift; however, 2 had called in sick in the morning, and there were no replacements available as all the other controllers had reached the maximum allowable amount of overtime.

To partially address this shortfall, NAV CANADA management decided to have one of the day shift controllers leave early and then return to work earlier than normal for the midnight shift. This controller was scheduled to arrive at 2100 instead of 2300.

In accordance with policy⁶, the ground / clearance delivery controller (hereafter referred to as the ground controller) was removed from control duties following the runway incursion. Another controller, who was scheduled to arrive at 2300, was then contacted to come in early and arrived at 2000.

Consequently, for approximately 40 minutes, the occurrence airport controller worked all 3 positions: airport, ground, and clearance delivery. The ground controller remained in the control tower and answered the phone and conducted automatic terminal information service (ATIS) tasks.

Staff shortages were common at the Ottawa tower. NAV CANADA's target number of controllers for staffing at the Ottawa tower is 23. At the time of the occurrence, the tower had 24 qualified controllers on staff, but 5 were unavailable for control duties due to temporary medical disqualification and parental leave. In addition, 2 trainees were progressing through the unit qualification training program.

NAV CANADA had been actively engaged in trying to resolve the staff shortfall, but efforts had been unsuccessful. The staffing situation was expected to continue until more controllers could be added through the training stream.

Ottawa tower Extended Computer Display System procedures

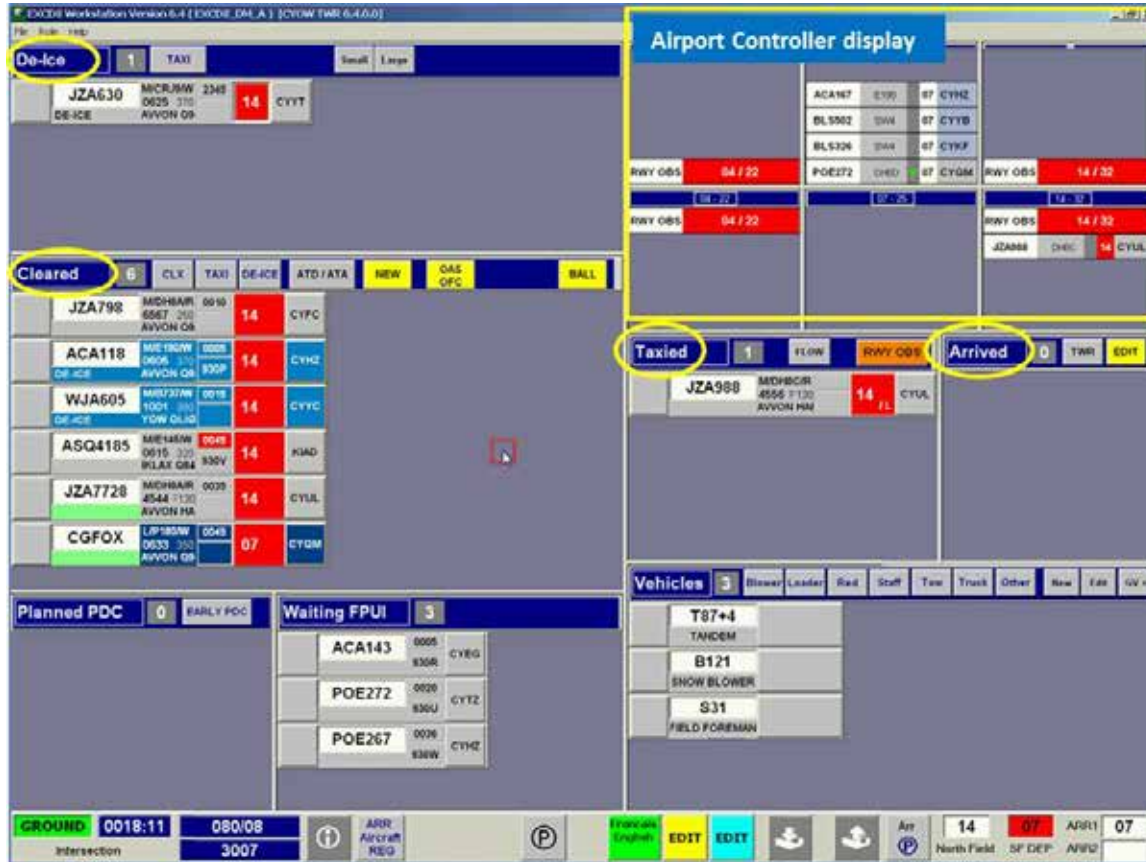
The Ottawa tower is equipped with EXCDS. Each departing aircraft within EXCDS is represented by an electronic flight data entry (FDE), which displays information about the aircraft, including the aircraft identification (ACID), type and route; proposed departure time;

⁵ The clearance delivery controller is the duty controller assigned to the clearance delivery position in an airport control tower. (Source: *Ottawa Tower Unit Procedures Manual*)

⁶ NAV CANADA, *Operations Investigations Guidelines Manual*, section 500

planned runway; and destination. In addition, various colours are used to communicate information to the controller. For example, in Figure 2, the light green highlighting on an FDE indicates aircraft communicating in French, while red runway highlighting designates aircraft for which a departure release is required from the terminal controller,⁷ who is located at the Montréal area control centre.

Figure 2. Capture of the ground controller's Extended Computer Display System display screen at 0018:11 UTC (1918:11 EST), immediately prior to transfer of responsibility for Runway 14/32 (Source: NAV CANADA, with TSB annotations)



FDEs for departing aircraft progress through a number of panels, including Cleared – for aircraft that have received an instrument flight rules (IFR) clearance – De-Ice, and Taxied. In addition, the ground controller’s display screen has an Arrived panel – for aircraft that have landed and will taxi to the apron – and a panel for Vehicles. The ground controller’s EXCDS display screen also reproduces the airport controller’s display in the top right-hand corner, with panels showing the arrivals and departures on each of the runways.

⁷ The terminal controller is the duty controller assigned to the terminal control position. (Source: NAV CANADA, *Air Traffic Control Manual of Operations*, Effective: 2013-10-17 to 2014-04-02, Definitions)

Once a clearance or instruction has been given to an aircraft, its FDE is forwarded to the appropriate panel. The NAV CANADA *Ottawa Tower EXCDS Manual* states: “For an aircraft that is taxiing for departure, forward the FDE to the Tower [airport] position (...)” When the ground controller transfers the FDE for a departing aircraft to the Taxied panel, it will appear on the airport controller’s EXCDS in the Departures panel for the intended departure runway. Once the FDE appears in this area, the airport controller will be able to integrate the aircraft into their planning.

Departures will be sequenced on the ground and airport controllers’ display screens in the order in which the ground controller forwards the FDE to the Taxied panel. Once an FDE has been forwarded to the Taxied panel, the ground controller can modify the departure sequence on its display screen; however, these changes will not be seen by the airport controller. Verbal coordination would be needed to have the airport controller manually update their EXCDS to reflect the new departure sequence.

The EXCDS also provides red runway obstruction (RWY OBS) headers that are used when a runway is unavailable for takeoff and landing and is under the jurisdiction of the ground controller. These can be seen in Figure 2 for Runways 04/22 and 14/32. Since the runway obstruction markers represent exchange of responsibility for the runway, when the airport and ground positions are not combined, only the airport controller can insert the runway obstruction markers and only the ground controller can remove them.

The NAV CANADA *Ottawa Tower EXCDS Manual* describes the use of the highlight function for the ground control position. The manual states that the light blue is to be used to indicate that an aircraft is pushing back from the gate, while the dark blue is used: “as a reminder that the FDE requires action (i.e., a new code to be issued, change of flow time to be relayed, etc.)”

Controller practices using the Extended Computer Display System

Section 9.7 of the *Ottawa Tower Unit Operations Manual* (UOM) requires the ground controller to “maintain an up-to-date record on the EXCDS Ground display of all aircraft and vehicles operating on the manoeuvring areas.”

On the night of the occurrence, the majority of aircraft were proceeding to the de-icing pad prior to departure. For these aircraft, the ground controller transferred the FDE from Cleared to De-Ice upon issuing a taxi clearance to the de-icing pad, and from De-Ice to Taxied when the aircraft was issued a taxi clearance upon leaving the de-icing pad. For aircraft not de-icing, the ground controller’s practice was to leave the FDE in the Cleared panel, highlight it in dark blue when the taxi clearance was issued, and transfer the FDE to the Taxied panel when the aircraft approached the departure runway.

The investigation determined that the ground controllers’ practices varied significantly in the use of EXCDS functionality for departing aircraft. Specifically, the timing of moving the FDE to the Taxied panel differed – some ground controllers transferred the FDE upon issuing the taxi clearance, and others transferred the FDE once runway crossings were complete and the

departure sequence was known. In addition, controllers were using the highlighting function differently to assist with runway crossings – some controllers highlighted FDEs in dark blue to indicate an aircraft that had been cleared across a runway, and others used the highlighting to indicate an aircraft that had been instructed to hold short and was awaiting a clearance to cross a runway.

Air traffic control procedures

Section 16.2 of the UOM provides criteria for opening or closing the clearance delivery position. It states:

When staffing permits, the Clearance Delivery position must be opened and not combined with any other control position whenever at least one of the following conditions exists:

- Snow removal is in progress on the manoeuvring areas
- Numerous flow control programs are in effect
- De-icing operations
- Emergency situations, or when ARFF [aircraft rescue and fire fighting] is on stand-by
- When changing weather conditions warrant frequent ATIS updates.

At the time of the occurrence, 4 of the 5 conditions existed, but with only 2 controllers on duty, the clearance delivery position could not be opened and remained combined with the ground position. The UOM did not provide guidance with respect to operations when any of the conditions listed in section 16.2 existed and staffing shortages would not permit the opening of the clearance delivery position.

The investigation revealed that, in order to maintain the workload at a manageable level during periods of staffing shortages, the options available to the 2 controllers on duty included establishing flow control into the airport such as requesting increased spacing between arrivals from the terminal controller. Exercising such option would have had a greater impact on the workload for the airport position than for the ground position. It was neither considered nor exercised by the controllers on duty at the time of the occurrence.

Runway 07 was in use for arrivals and departures, and Runway 14 was being used for departures of aircraft leaving the de-icing pad. As a consequence, the ground and airport controllers frequently exchanged responsibility for the control of Runway 14. Under these circumstances, best practices for issuing taxi instructions to any aircraft taxiing to Runway 07 would include a restriction to hold short of Runway 14.

C-GFOX was initially proceeding along an uncontrolled taxiway from a point at the airport that was not visible to the ground controller. This taxiway joined a controlled taxiway in the vicinity

of where landing aircraft were exiting Runway 07 (intersection of taxiways G, B, and F). Nonetheless, the ground controller issued C-GFOX a taxi clearance without restriction for departure on Runway 07.

Exchange of runway responsibility

Ground controllers routinely respond to requests for control of a runway from the airport controller. When the ground controller receives such a request, they scan a number of sources of information, including their EXCDS, the ground radar, and the airport manoeuvring area, to verify that no conflicts exist prior to removing the runway obstruction marker from the EXCDS.

When C-GFOX was issued taxi instructions, the ground controller had responsibility for Runway 14. When the responsibility for Runway 14 was transferred to the airport controller, there was no indication that the ground controller recollected or recognized that C-GFOX was about to cross Runway 14. Around the time that the responsibility for Runway 14 was transferred to the airport controller, the ground controller's focus was on tasks related with snow removal equipment.

Section 361.7 of the NAV CANADA *Air Traffic Control Manual of Operations* (ATC MANOPS) states, "do not authorize taxiing aircraft or ground traffic to operate on a runway being used for landing and takeoff unless you have coordinated with the airport controller."

Workload at the combined ground / clearance delivery position

Controller workload results from the interaction between task demands presented by the traffic situation and the strategies to manage workload adopted by the air traffic controller. It has been found to be impacted by situational factors including traffic volume, traffic density, and complexity factors. It is also dependent on the controller's response to the traffic situation, and research has shown that controllers tend to adopt strategies which optimize workload and traffic efficiency⁸. The investigation determined that the workload at the combined ground / clearance delivery position was assessed as moderate and complex.

The ground controller took responsibility for the position 38 minutes before the occurrence, after having just worked the airport position. At 1842, when the transfer of position responsibility occurred, the ground controller was responsible for 13 aircraft and 1 set of snow removal vehicles. Specifically, 3 aircraft had received their IFR clearance⁹, 6 aircraft were being

⁸ S. Loft, P. Sanderson, A. Neal, and M. Mooij (2007), "Modeling and Predicting Mental Workload in En route Air Traffic Control: Critical Review and Broader Implications", *Human Factors*, Vol. 49, No. 3, June 2007, pp. 376–399

⁹ An air traffic control (ATC) clearance is an authorization issued by an ATC unit for an aircraft to proceed within controlled airspace in accordance with the conditions specified by that unit. (Source: NAV CANADA, *Air Traffic Control Manual of Operations*, Effective: 2013-10-17 to 2014-04-02, Definitions)

de-iced in preparation for departure, 3 were taxiing to their departure runways, and 1 aircraft had recently landed and was taxiing to the apron. A number of situations were increasing the complexity of the operation, including vehicles conducting snow removal operations; flow control; de-icing operations; and the use of intersecting runways.

The level of workload and complexity had not changed considerably by 1859, when JZA988 was issued taxi instructions to the de-icing pad. At 1907, the ground controller began composing an ATIS message, a task which took approximately 3 minutes. The ground controller completed the ATIS message without interruption.

At 1915, the ground controller issued the IFR clearance to C-GFOX.

A 40-second period of quick radio transmissions and some multi-tasking followed, including

- acknowledging a request from an aircraft to push back;
- receiving a flow time for a departure via EXCDS and providing this time to the aircraft;
- answering a phone call informing the airport controller of cancellation of flow control to one airport; and
- receiving a report from one vehicle that it was clear on the apron.

During this period, radio transmissions coincided with a telephone call, and on one occasion, 2 radio transmissions occurred simultaneously.

At 1916, C-GFOX called for taxi instructions and was instructed to taxi to Runway 07 across Runway 14/32. In the following 2 minutes, until responsibility for Runway 14 was transferred to the airport controller, the ground controller was occupied completing a number of tasks. Taxi instructions were issued to JZA988, which was leaving the de-icing pad. As with all departures from Runway 14, this involved confirming that the distance available for takeoff from the Taxiway L intersection was adequate for the aircraft, and entering the departure intersection into EXCDS. This task was completed approximately 1 minute after the taxi clearance was issued. In the interim, the ground controller acknowledged a call from one set of snow removal vehicles and updated the related FDE, and removed another FDE from the Vehicles panel for the vehicle that had reported clear at 1915. Immediately after completing these tasks, the ground controller acknowledged a call from another snow removal vehicle, and then removed the runway obstruction marker to transfer responsibility for Runway 14 to the airport controller.

At the time the responsibility for Runway 14 was transferred to the airport controller, the ground controller was responsible for 8 aircraft and 3 sets of vehicles (Figure 2). Six aircraft were in the Cleared panel and, of these, 2 were highlighted in light blue to indicate that they had pushed back, and 1 was highlighted in dark blue (C-GFOX) to indicate that it was taxiing. There was 1 aircraft in the De-Ice panel and 1 aircraft in the Taxied panel (JZA988). The situation with the vehicles was changing quickly, with a number of vehicles entering and exiting the field, which required a number of radio communications and EXCDS updates. There were some slight delays observed in completing EXCDS updates during this period, but tasks were carried out as soon as the controller could do so. There were no indications of task

shedding, which would have indicated that the workload was beyond the capability of the controller.

The ground controller recognized the conflict after the FDE for C-GFOX was transferred to the Taxied panel at 1919:50. Between the time the responsibility for Runway 14/32 was transferred to the airport controller and the time the conflict was detected, the ground controller acknowledged transmissions or provided clearances for 2 vehicles and 1 aircraft, and made several updates to EXCDS FDEs.

Human factors

There is considerable human factors literature available that provides some explanations as to why people have slips of action or memory lapses. One example is as follows:

[...] slips of action are not random events. They fall into predictable patterns and are associated with three distinct causal factors:

- The performance of routine, habitual task in familiar circumstances.
- Attention is 'captured' by some unrelated preoccupation or distraction.
- There is some change, either in the plan of action or in the surroundings¹⁰.

The predictable nature of errors and of memory underscores the importance of memory aids in dynamic systems to minimize the probability that elements will be overlooked or forgotten.

In such situations, errors can occur when attentional checks are not made at the appropriate time, or when they are made but result in an incorrect assessment of the situation. In this instance, the ground controller either did not perform the scan at the appropriate time and relied upon memory, or performed the scan but was not alerted to the presence of C-GFOX.

In this occurrence, the ground controller had planned to have C-GFOX taxi to Runway 07 without restriction. This plan was not monitored to determine viability when the responsibility for Runway 14 was being transferred.

Pilots' knowledge of other aircraft movements

The CYOW ATIS stated that Runway 07 was being used for arrivals and departures. The ATIS did not mention that Runway 14 was also being used for departures.

¹⁰ J. Reason and A. Hobbs (2003), *Managing Maintenance Error A Practical Guide*, p. 48

Based on the timing of the radio transmissions from the ground controller, C-GFOX had an opportunity to hear that aircraft were using Runway 14 for departure. C-GFOX was instructed to remain on the ground frequency and to contact the tower once holding short of Runway 07.

When C-GFOX was issued taxi instructions, JZA988 was at the de-icing pad and was not monitoring the ground frequency. JZA988 was unaware that C-GFOX was taxiing to Runway 07 without a restriction to hold short of Runway 14.

As C-GFOX was approaching Taxiway C from the apron, there were several snow removal vehicles to its right. These vehicles were equipped with flashing lights. The Piaggio P-180 is a relatively low-profile aircraft and the eye-wheel height is approximately 72 inches above the taxiway surface. The Piaggio P-180 cockpit is equipped with a map light on the co-pilot's right panel which may have been on to read the checklist.

The aircraft taxi light was on; however, it is not very bright and its location, low on the nose wheel landing gear, would make it difficult for another aircraft to see it.

The JZA988 flight crew did not see C-GFOX cross the runway in front of them; however, the crew were able to see past the intersection of Runway 14 and Taxiway C, and had noted an aircraft landing on Runway 07 just before they were cleared for takeoff. Neither C-GFOX nor JZA988 was aware of the runway incursion.

TSB Watchlist

Risk of collision on runways is a 2014 Watchlist issue

The Watchlist is a list of issues posing the greatest risk to Canada's transportation system; the TSB publishes it to focus the attention of industry and regulators on the problems that need addressing today.

Airport operations require aircraft and vehicles to move between aprons, taxiways, and runways. Sometimes this movement creates conflicts between aircraft, or between aircraft and vehicles. These conflicts can also happen when aircraft or vehicles mistakenly occupy an active takeoff or landing area.

In a 10-year period, from 2005 through 2014, there were 4232 of these conflicts, known as runway incursions, in Canada¹¹. Given the millions of takeoffs and landings each year, incursions are rare, but their consequences can be catastrophic.

¹¹ Source: Transport Canada, Civil Aviation Daily Occurrence Reporting System (CADORS)

Since the TSB first placed this issue on its Watchlist in 2010, the number of these occurrences has remained too high: in 2010 there were 346, followed by 454 in 2011, 429 in 2012, 381 in 2013, and 349 in 2014. They continue to occur about once a day.

The TSB has reported publicly on the risk of collisions on runways¹². The Board remains concerned that incursions and the risk of collisions will continue until better defences are put in place.

TSB laboratory reports

The TSB completed the following laboratory report in support of this investigation:

- LP237/2013 – FDR [flight data recorder] Data & ASDE [airport surface detection equipment] Radar Analysis

¹² TSB aviation investigation reports A99W0036, A00W0062, A00Q0114, A00P0206, A01O0299, A03C0099, A04P0047, A04P0397, A04Q0089, A07O0305, A08H0002, A08O0215, A09W0026, A09W0037, A10W0040, A11Q0170 and A13O0045.

Analysis

General

In this occurrence, the ground controller transferred responsibility for a runway which an aircraft had been cleared to cross. This analysis will focus on the factors which contributed to the ground controller not identifying the conflict, including controller workload, and working practices which reduced the effectiveness of the Extended Computer Display System (EXCDS) for maintaining controller situational awareness. In addition, this analysis will examine the issue of controller staffing at the Ottawa tower.

Taxi instruction

Runway 07 was in use for arrivals and departures. Runway 14 was also being used for departures of aircraft leaving the de-icing pad. As a consequence, the ground and airport controllers frequently exchanged responsibility for the control of Runway 14. Under these circumstances, best practices for issuing taxi instructions to any aircraft taxiing to Runway 07 should include a restriction to hold short of Runway 14. This would provide an added defence for the prevention of runway incursions, especially when controller responsibility for Runway 14 is frequently changing.

C-GFOX was initially proceeding along an uncontrolled taxiway from a point at the airport that was not visible to the ground controller. This taxiway joined a controlled taxiway in the vicinity of where landing aircraft were exiting Runway 07 (intersection of taxiways G, B and F). Nonetheless, the ground controller issued C-GFOX a taxi clearance without restriction for departure on Runway 07. Incremental restrictions would have increased the ground controller's awareness of C-GFOX's location.

The ground controller issued instructions to C-GFOX to taxi unrestricted from the Royal Canadian Mounted Police apron to Runway 07, despite the frequent use of Runway 14 for departing aircraft.

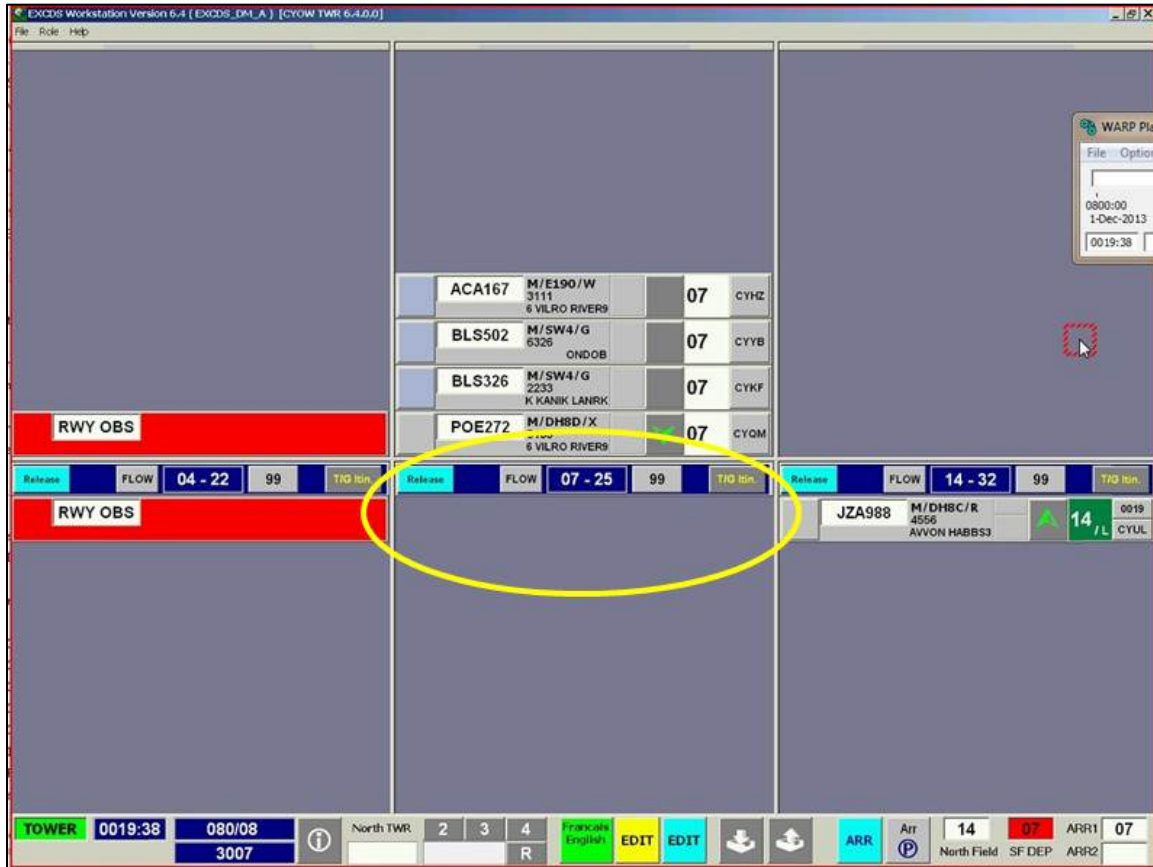
Extended Computer Display System procedures

The *Ottawa Tower EXCDS Manual* requires that the ground controller forward the flight data entry (FDE) of an aircraft taxiing for departure to the Taxied panel so that an FDE will be generated in the applicable Departure panel of the airport controller's display screen. However, the *Ottawa Tower Unit Operations Manual (UOM)* and unit directives do not indicate when to initiate this transfer, leaving the decision to the discretion of individual controllers.

It was the ground controller's practice to delay forwarding the FDE until aircraft were closer to the departure runway. The FDE was left in the Cleared panel, and C-GFOX was highlighted in dark blue as a reminder that some action was required. Following the issuance of taxi instructions to C-GFOX, the ground controller did not initially forward the FDE from the

Cleared panel to the Taxied panel, and therefore the airport controller's EXCDS did not indicate that C-GFOX was taxiing for Runway 07 (Figure 3).

Figure 3. Capture of airport controller's Extended Computer Display System display screen showing no aircraft taxiing for Runway 07 (Source: NAV CANADA, with TSB annotation)



The airport controller was unaware that C-GFOX was taxiing for Runway 07 when the take-off clearance was issued to JZA988 at 1919:28.

The investigation revealed that there are inconsistencies as to when ground controllers forward the FDE of a taxiing aircraft from the Cleared panel to the Taxied panel. If the air navigation service provider does not provide clear direction as to when FDEs have to be forwarded within EXCDS, there is a risk that control instructions will be issued without a complete understanding of the operational environment.

Exchange of runway responsibility

The ground controller and the airport controller had to coordinate their activities prior to exchanging the responsibility for Runway 14. Therefore, the ground controller had to verify the location of all vehicles and aircraft. In this occurrence, the ground controller should have determined the location of C-GFOX and issued a restriction to hold short of Runway 14 if the aircraft had not yet crossed it.

As part of the coordination prior to exchanging responsibility for a runway, the ground controller scans a number of sources of information to verify that no conflicts exist prior to removing the runway obstruction marker from the EXCDS. This scan includes their EXCDS, the ground radar and the airport manoeuvring area. In such situations, errors can occur when attentional checks are not made at the appropriate time, or when they are made but result in an incorrect assessment of the situation. In this instance, the ground controller either did not perform the scan at the appropriate time and relied upon memory, or performed the scan but was not alerted to the presence of C-GFOX.

A slip of action can be caused by a change, either in the plan of action or in the surroundings. In this occurrence, the ground controller had planned to have C-GFOX taxi to Runway 07 without restriction. This plan was not monitored to determine viability when the responsibility for Runway 14 was being transferred.

The predictable nature of errors and of memory underscores the importance of memory aids in dynamic systems to minimize the probability that elements will be overlooked or forgotten. One such system is EXCDS, which provides controllers with a depiction of the status of the aircraft under their control.

The ground controller's practice of delaying forwarding the taxiing aircraft's FDE from the Cleared panel to the Taxied panel withheld an indication to the airport controller that the aircraft was taxiing for departure on Runway 07 and reduced the airport controller's ability to develop a complete traffic picture and plan accordingly. This practice also may have contributed to the ground controller's lack of awareness of where C-GFOX was prior to exchanging runway responsibility. The ground controller did not verify the position of C-GFOX relative to Runway 14 prior to transferring the responsibility for Runway 14 to the airport controller.

Following de-icing, the ground controller instructed JZA988 to taxi to Runway 14 and to contact the tower once holding short. When contacted by JZA988, the airport controller instructed the aircraft to line up and wait on Runway 14. Upon exchange of the responsibility for Runway 14, the airport controller completed a scan of the airport environment and the EXCDS display screen. The airport controller saw an aircraft on the apron (C-GFOX), but expected it to turn towards the de-icing pad rather than cross Runway 14 because there was no indication on the EXCDS display screen that there was an aircraft taxiing for Runway 07.

The airport controller cleared JZA988 for takeoff on Runway 14, and C-GFOX subsequently entered Runway 14 as JZA988 was departing, leading to the runway incursion and risk of collision.

Ottawa tower staffing and controller workload

Workload at the time of the occurrence was described as moderate and complex due to the weather, snow removal operations, the use of intersecting runways, and flow control. Although unit procedures dictate that the clearance delivery and ground positions should not be

combined in such situations, a staff shortage in the tower meant that there were no additional controllers available for recall. Steps had been taken to minimize the period of time when only 2 controllers would be on duty.

There were some slight delays observed in completing EXCDS updates during this period, but tasks were carried out as soon as the ground controller could do so. There were no indications of task shedding, which would have indicated that the workload was beyond the capability of the controller.

Options available to the 2 controllers on duty to maintain workload at a manageable level included establishing flow control into the airport such as requesting increased spacing between arrivals from the terminal controller. However, it was neither considered nor exercised by the controllers, indicating that the controllers believed that the workload was manageable.

Staffing shortages were common at the Ottawa tower, particularly toward the end of a shift cycle when most controllers had already worked the maximum allowable amount of overtime. Although the unit had more than the target number of controllers on staff, more than 20% (5 of 24) were unavailable for work at the time of the occurrence. Efforts to add controllers had been unsuccessful and, as a result, the situation was expected to continue until more controllers could be added through the training stream. Meanwhile, the level of available staff at the Ottawa tower was leading to regular staff shortages and significant amounts of overtime for many controllers, increasing the risk of occurrences related to workload and controller fatigue.

With only 2 controllers on duty for a 4-person shift, the requirement to remove a controller from duty following the occurrence increased the workload and complexity of the one remaining controller's duties, thereby increasing the risk of error.

If there is insufficient staff available to deal with staffing shortfalls, there is an increased risk of error due to workload and fatigue.

Aircrew awareness of the other aircraft

The crew of JZA988 was not monitoring the ground frequency when C-GFOX was given taxi instructions for Runway 07. The crew of C-GFOX was unaware that JZA988 had been cleared for takeoff on Runway 14. Additionally, the incident occurred at night with light snow falling. This, combined with the lights from several snow removal vehicles located to the right of C-GFOX and the inside cockpit lighting, may have made it more difficult for the crew of C-GFOX to detect JZA988 near the Runway 14 threshold. Therefore, neither crew was aware of the other aircraft and the possible conflict the other posed.

Findings

Findings as to causes and contributing factors

1. The ground controller issued instructions to C-GFOX to taxi unrestricted from the Royal Canadian Mounted Police apron to Runway 07, despite the frequent use of Runway 14 for departing aircraft.
2. The *Ottawa Tower EXCDS Manual* requires that the ground controller forward the flight data entry (FDE) of an aircraft taxiing for departure to the Taxied panel so that an FDE will be generated in the applicable Departure panel of the airport controller's display screen. However, the *Ottawa Tower Unit Operations Manual* and unit directives do not indicate when to initiate this transfer, leaving the decision to the discretion of individual controllers.
3. Following the issuance of taxi instructions to C-GFOX, the ground controller did not initially forward the C-GFOX flight data entry from the Cleared panel to the Taxied panel and, therefore, the airport controller's Extended Computer Display System display screen did not indicate that C-GFOX was taxiing for Runway 07.
4. The ground controller did not verify the position of C-GFOX relative to Runway 14 prior to transferring the responsibility for Runway 14 to the airport controller.
5. The airport controller cleared JZA988 for takeoff on Runway 14, and C-GFOX subsequently entered Runway 14 as JZA988 was departing, leading to the runway incursion and risk of collision.

Findings as to risk

1. If there is insufficient staff available to deal with staffing shortfalls, there is an increased risk of error due to workload and fatigue.
2. If the air navigation service provider does not provide clear direction as to when flight data entries have to be forwarded within the Extended Computer Display System, there is a risk that control instructions will be issued without a complete understanding of the operational environment.

Safety action

Safety action taken

NAV CANADA

NAV CANADA reviewed its procedures for operating when short-staffed. As a result, an Ottawa tower operations directive was issued on 8 January 2014, providing restrictions for operating while short-staffed. The directive was the subject of a mandatory verbal briefing.

Ottawa tower supervisors are encouraging controllers to ask the Ottawa terminal controller for additional spacing, and explain the reason for the request, if required, when short-staffed.

The Ottawa tower issued the Operational Directive, OD 2014-15, which has been incorporated in the Unit Operations Manual. This directive instructs controllers to indicate on EXCDS that a vehicle or aircraft is cleared to cross a runway by activating the Runway Crossing Indicator (RCI) on the FDE. The RCI can only be deactivated once the aircraft or vehicle has left the protected area on the other side of the runway.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 10 June 2015. It was officially released on 16 July 2015.

Visit the Transportation Safety Board's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

Appendices

Appendix A – Ottawa Macdonald-Cartier International Airport diagram

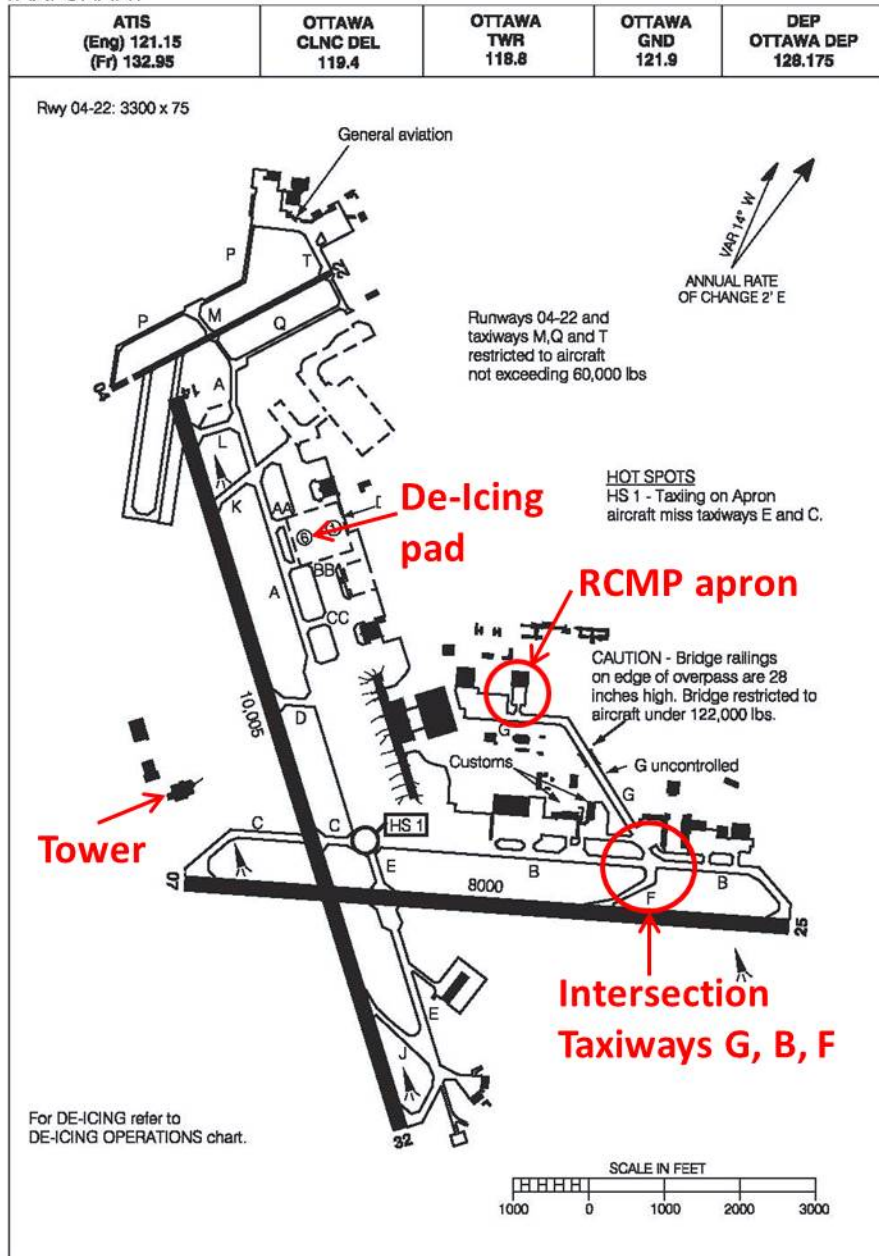
Canada Air Pilot

Effective 0901Z 17 OCT 2013 to 0901Z 12 DEC 2013

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OTTAWA/MACDONALD-CARTIER INTL
OTTAWA ON

TAXI CHART



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TAXI CHART

OTTAWA ON
OTTAWA/MACDONALD-CARTIER INTL

EFF 2 MAY 13

CHANGE: Annual rate of change

NAD83

Source: NAV CANADA, *Canada Air Pilot*, with TSB annotations

Note: Not for navigation purposes