Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A08O0215

LOSS OF SEPARATION / RISK OF COLLISION

NAV CANADA
TORONTO / LESTER B. PEARSON INTERNATIONAL AIRPORT
MISSISSAUGA, ONTARIO
09 AUGUST 2008

Canada

Aviation Investigation Report

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Summary

At 1608 Eastern Daylight Time, the Royal Dutch Airlines flight KLM47V, a Boeing 747-400 aircraft (registration PH-BFY, serial number 30455), was cleared to land on Runway 05 at Toronto/Lester B. Pearson International Airport. Shortly thereafter, a Boeing 757-200 aircraft (registration G-FCLI, serial number 26275), operating as Thomas Cook Airlines flight TCX4L, was cleared for take-off from Runway 33R. The airport controller, upon realizing that there was a conflict, instructed TCX4L to abort the take-off. The flight crew of TCX4L initiated a high-speed reject and exited Runway 33R without incident. At the time of the occurrence, due to weather conditions, runway operations were changing from aircraft arriving on Runway 06L and departing from Runway 33R to arriving on Runway 05 and departing from Runway 06L. KLM47V was the first aircraft to land on Runway 05 and TCX4L was to be the last aircraft to take-off from Runway 33R. A loss of separation and risk of collision occurred when KLM47V had been cleared to land on Runway 05 at the time that TCX4L was cleared to take-off from Runway 33R.

Ce rapport est également disponible en français.

Other Factual Information

Sequence of Events

KLM47V was on a flight from Amsterdam Airport Schiphol, the Netherlands (EHAM), to Toronto/Lester B. Pearson International Airport (LBPIA), Ontario (CYYZ). At 1551 [1], KLM47V was level at 10 000 feet above sea level, 36 nautical miles (nm) northeast of LBPIA and was told by the Toronto arrival controller to expect to land on Runway 06L.

TCX4L was a scheduled flight from CYYZ for London/Gatwick Airport (EGKK), United Kingdom, with a departure time of 1555. TCX4L had received an instrument flight rules (IFR) clearance from clearance delivery at 1537 that included a departure from Runway 33R.

At 1558, the Toronto area control centre (ACC) shift manager coordinated a change in runway operations from landing on Runway 06L and departing from Runway 33R to landing on Runway 05 and departing from Runway 06L. To accommodate the change, KLM47V, which was 5.5 nm northeast on the downwind, was changed to arrive on Runway 05. At 10 nm final, KLM47V was cleared for the instrument landing system (ILS) approach on Runway 05 and instructed to switch to tower frequency upon crossing the Meadowvale non-directional beacon. KLM47V called the tower at 4 nm final at 1608 and was cleared to land on Runway 05. At the same time the airport controller was receiving the call from KLM47V, he was requesting confirmation from the coordinator controller about which aircraft would be the last in sequence to land on Runway 06L.

At 1606:44, TCX4L called the tower and advised ready for departure in sequence behind the aircraft ahead. The airport controller did not respond to TCX4L. At 1608:19, TCX4L called airport control a second time advising ready to depart. The airport controller instructed TCX4L to line up on Runway 33R and wait. At 1608:40, TCX4L was cleared for take-off from Runway 33R, was advised the wind was 150 degrees at 10 knots, and was provided with a tailwind advisory. TCX4L acknowledged the take-off clearance. The airport surface detection equipment (ASDE) showed that TCX4L commenced the take-off roll at 1609:16. At that time, KLM47V was 1.0 nm from the threshold of Runway 05 with a clearance to land.

Aborted Take-off

Shortly after clearing TCX4L for take-off, the airport controller, who had turned to look at the ILS monitor, noticed KLM47V on short final approach for Runway 05. The tower supervisor also saw both KLM47V on short final and TCX4L on the take-off roll and yelled for the airport controller to abort the take-off. KLM47V crossed the threshold of Runway 05 at 1609:41, the same time the airport controller instructed TCX4L to abort the take-off. TCX4L had accelerated to a ground speed of 108 knots at that point, according to the recorded ASDE information.

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[1] All times are Eastern Daylight Time (Coordinated Universal Time minus four hours).

TCX4L reached a maximum of 126 knots. The aircraft came to a stop on Runway 33R between Romeo and Bravo 4 Taxiways at 1610:18, approximately 6260 feet from the threshold of Runway 33R (approximately 3490 feet from the intersection with Runway 05). By the time TCX4L stopped, KLM47V had passed the Hotel 3 high-speed exit on Runway 05 (approximately 1480 feet before the intersection with Runway 33R) travelling at 53 knots (see Appendix A – Aircraft Positions at 1610:18).

KLM47V was not aware that another aircraft had been cleared for take-off from a crossing runway. The crew did not initiate actions beyond those required for a normal landing on Runway 05, and had decelerated to taxi speed prior to reaching the intersection with Runway 33R. TCX4L was not aware that another aircraft had been cleared to land on the crossing runway; however, the crew actioned the abort instruction from the tower quickly and brought the aircraft to a stop before the intersection with Runway 05. The aircraft was taxied to the ramp under its own power. There was no damage to the aircraft.

Weather Conditions

On the day of the incident, southern Ontario was under the influence of an unstable air mass that produced intense thunderstorm activity. As a result, conditions at the airport had varied from visual meteorological conditions with light rain and winds from the northeast at 6 knots, to instrument meteorological conditions with thunderstorms, heavy rain, and winds from the northwest at 24 knots, gusting to 29 knots. The hourly weather report at 1600 was wind 110° True (T) at 4 knots, visibility 15 statute miles, few clouds at 2500 feet above ground level (agl), 4000 feet agl scattered, ceiling 13 000 feet agl broken, 14 000 feet agl broken, temperature 16 C°, dew point 14 C°, altimeter 29.80 inches of mercury, remarks recent thunderstorms, rain.

Control Tower Staffing

The control tower was short-staffed by one controller for the evening shift on the day of the incident, which limited the runway combinations that could be used and, at times, required a reduction in the arrival acceptance rate. However, this was not considered to be a factor in this incident. The north and south airport control functions were combined at either the north or south airport control position, depending on the runway operation.

The airport controller involved in the incident had been qualified in the tower for nine months. The controller had worked five consecutive evening shifts prior to the day of the incident and had been scheduled for an overtime shift the next day. On the day of the incident, the airport controller indicated feeling well-rested and was scheduled for duty for the evening shift starting at 1400.

At the beginning of the shift, the airport controller initially took over the clearance delivery position. After a break, the airport controller returned to the tower cab and assumed control of the combined (north and south) airport control functions established at the north airport operating position. At 1509, there was a change to arriving on Runway 06L and departing from Runway 33R. With this change, the airport controller opted to move to the south airport control

position, which provided a better view out the window of the arrival and departure paths. At 1558, the decision was made to change to an arriving on Runway 05 and departing from Runway 06L operation.

The complexity level was moderate at the time of the incident due to the runway change activities. The traffic level was also moderate. In the 2 ½ minutes between issuing the landing clearance to KLM47V and it turning off Runway 05, the airport controller was responsible for seven aircraft, using a combination of Runways 06L, 33R, and 05.

Human Factors – Memory

Memory is the ability to sense, store, and retrieve information when needed. Human memory is composed of three sub-systems: the sensory stage, working memory, and long-term memory. Information must pass through the working memory before going into the long-term memory. The transfer of information from the sensory stage to the working memory is achieved by encoding. [2] The human working memory is limited in the amount of information that it can simultaneously handle. Air traffic control is very dynamic and involves processing a fairly large amount of transient information, such as current traffic and operating runways in a very short span of time. This information must be sensed, encoded, and retained for short periods of time. Given the storage limitations of the working memory and the frequent disruptions associated with air traffic control communication, there is a risk of forgetting information. [3]

Air Traffic Control Operational Procedures

The arrangement [4] between the Toronto ACC, which includes the terminal control unit (TCU), traffic management unit (TMU), and the Toronto control tower, describes the coordination and steps required for changing a runway. Paragraph D1 of the arrangement states, in part:

> Any requests for a configuration change at LPBIA must be coordinated through the Shift Manager. The Shift Manager will coordinate with the Toronto TMU, Toronto Terminal Supervisor and Toronto Control Tower Supervisor, as appropriate, regarding LPBIA configuration changes.

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2 M.S. Sanders and E.J. McCormick, *Human Factors in Engineering and Design*, McGraw-Hill, 1992, pages 65-68

3 D.J. Garland, E.S. Stein, and J.K. Muller, *Handbook of Aviation Human Factors – Air Traffic Controller Memory: Capabilities, Limitations and Volatility*, Lawrence Erlbaum Associates, 1999, pages 455-458

4 An administrative or operational accord between NAV CANADA units regarding the provision of Air Traffic Services, Reference: *Air traffic Services Administration and Management Manual* (ATSAMM) - Definitions

Also, paragraph D2 of the arrangement states:

> The Toronto TCU, Toronto Control Tower and Toronto TMU shall coordinate to achieve runway changes; and The Toronto TCU Coordinator shall point-out the last aircraft to arrive on the current arrival runway, and the first aircraft to arrive on the new arrival runway to the Toronto Pearson Tower Controller.

During a runway change, the ACC staff members are responsible for ensuring that navigation aids are properly functioning for the runway in use, and the tower staff has the responsibility for approach and runway light set-up.

The information about an upcoming runway change is communicated to the tower staff by the tower supervisor. There is no guidance as to how this information is to be disseminated. Coordination among the various operating positions such as ground and airport control then takes place to ensure that airport lighting, runway ownership, and taxi routes are properly coordinated. The last step before the runway change becomes effective is the coordination between the tower and terminal to indicate which aircraft will be the last to land on the old arrival runway and the first to land on the new arrival runway. This information is the trigger that the new arrival flow is in effect and to start taxiing departing aircraft to the new runway. A review of the recorded audio information for that afternoon revealed that during several runway changes, the required coordination, as noted above, between the tower and terminal was not always completed in accordance with published procedures.

At 1558, the shift manager decided to change the arrival operations to Runway 05 because the previously unavailable ILS was back in service. As the change progressed, both the supervisor and the airport controller became busy with tasks, including:

- receiving information on departure restrictions that had to be implemented due to weather;
- ensuring that Runway 05 was properly set-up with respect to lighting and instrument approach aids;
- coordinating with various control positions in the tower for control of runways; and
- controlling aircraft approaching the old runway (06L) and the new active runway (05), as well as departures from Runway 33R.

Control Tower Displays

The Toronto ASDE displays ground targets on displays located at the airport and ground positions control consoles. The targets on the ASDE do not show the flight number or registration marks of aircraft or ground vehicles. The runway incursion monitoring and collision avoidance system (RIMCAS), a function built into the ASDE, can be configured to provide an alert to the controller if a potential or actual runway incursion is detected.

The ASDE at Toronto/LBPIA, which was installed in 1999, is not capable of providing an alert to the controller in situations where one aircraft is taking off on one runway and another aircraft is landing or taking off on a crossing runway, and there exists a risk of collision at the intersection of the two runways. Each controller sets up the configuration of the ASDE display in accordance with the requirements of the position and personal preferences.

Since 2005, NAV CANADA has installed ASDE with enhanced RIMCAS at other airports in Canada capable of providing alerts in the event two aircraft are approaching each other on crossing runways at high speed.

Other Occurrences during Runway Change Operations

The TSB is investigating a runway incursion incident (A08H0002) that occurred on 29 July 2008 at Toronto/LBPIA. In this incident, a Boeing 737-700 (B737), from Toronto to Vancouver, had been cleared for take-off from Runway 33L. A short time later, a ground controller cleared three vehicles to enter Runway 33L. The B737 was approximately a third of the way down the runway when the vehicles entered Runway 33L. The flight became airborne approximately 2500 feet before the location of the vehicles. At the time of the incident, a change in runway operations was taking place.

The TSB has also learned of a more recent incident on 13 January 2009 at Toronto/LBPIA. While using Runway 15L for landing and transitioning to a Runway 24L/R operation, the ground controller taxied an aircraft across Runway 15L with traffic landing. This incident is under investigation by NAV CANADA.

Analysis

The change in runway operation activities in the control tower appeared to be undertaken in a rushed environment. As a result, the time available to ensure that everything was in place for the new runway operation was reduced. While the airport controller was completing tasks of equipment set-up, coordinating with other positions in the tower, and the receiving departure restrictions, the first aircraft called for a landing clearance on the new runway. It is likely that these activities led to task saturation and resulted in memory lapses and errors. At the same time, the tower supervisor was also busy coordinating additional departure traffic restrictions with the TMU and could not monitor closely the activities surrounding the runway change. Tasks and activities must be balanced effectively so that the lower priority tasks such as receiving departure restrictions do not interfere with the primary task of switching to a new runway. Current written procedures do not provide detailed guidance for the tasks and activities that may require close attention and supervision during the change to a new runway operation.

At the time the take-off clearance was issued to TCX4L, there was no expectation by the airport controller that a conflict existed. The airport controller was more occupied with activities associated with the runway change, which took his attention away from controlling his traffic and contributed to his incorrect situational awareness, thus forgetting that KLM47V was landing on Runway 05.

The current RIMCAS installed at Toronto is not able to detect and warn the controller when two aircraft are approaching each other at high speed on crossing runways. Such a warning may have allowed the controller to issue abort instructions to TCX4L much earlier while the aircraft was traveling at a much slower speed.

Controller task saturation, incomplete inter-unit coordination, and a lack of comprehensive standard operating procedures for managing runway changes contributed to this loss of separation, leading to a risk of collision.

Findings as to Causes and Contributing Factors

1. The existing procedures between the tower and terminal for designating which aircraft are the last to arrive on the old runway and the first to arrive on the new runway were not followed, which resulted in KLM47V being transferred to tower control without the required pre-coordination.

2. There was a lack of standard operating procedures for the tower supervisor's role in managing runway operation change; the supervisor engaged in lower priority tasks and did not effectively manage the transition to the new runway operation.

3. The airport controller was required to action several activities simultaneously. When the take-off clearance was issued to TCX4L, the controller had likely become task saturated and, as a result, did not detect the conflict between KLM47V and TCX4L.

Finding as to Risk

1. The runway incursion monitoring and collision avoidance system (RIMCAS) at the Toronto airport is not capable of providing an alert to the controller in situations where one aircraft is taking off on one runway and another aircraft is landing or taking off on a crossing runway, and there exists a risk of collision at the intersection of the two runways.

Safety Action Taken

NAV CANADA has indicated that, as a result of this event, Toronto Tower has developed a checklist for the tower supervisor to verify that complete coordination and standard operating procedures for managing a safe and orderly runway change has been accomplished. In addition, the runway change procedure was included in recurrent training for Toronto/Lester B. Pearson International Airport (LBPIA) tower and for the Toronto area control centre (ACC) terminal control unit personnel. It is anticipated that this will aid the completion of coordination and standardize the operating procedures for managing a safe and orderly runway change.

The present airport surface detection equipment (ASDE)/runway incursion monitoring and collision avoidance system (RIMCAS) system at Toronto/LBPIA is being reviewed for replacement/upgrade to a full advanced surface movement guidance and control system (A-SMGCS). In addition, NAV CANADA, in conjunction with the Greater Toronto Airports Authority (GTAA), is pursuing the acquisition of multi-lateration, which could provide alerts to controllers for situations in which aircraft are approaching each other on crossing runways at high speed.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 10 July 2009.

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Appendix A – Aircraft Positions at 1610:18