Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A22O0146

RUNWAY INCURSION

Greater Toronto Airports Authority
Maintenance Vehicle 31
Toronto/Lester B. Pearson International Airport, Ontario
15 October 2022

Canada

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Summary

On 15 October 2022, at 0013 Eastern Daylight Time, during the hours of darkness, the maintenance vehicle designated as Maintenance 31, operated by the Greater Toronto Airports Authority at Toronto/Lester B. Pearson International Airport, Ontario, crossed the runway holding position marking for the east side of Runway 15R on Taxiway J, even though the driver had received and read back a taxi clearance that included an instruction to hold short of the runway.

At the time of the runway incursion, an Air Canada Boeing 737 operating as flight ACA 174 was on short final approach for Runway 15R, approximately 0.5 nautical miles from the runway.

The tower controller, who was watching the approaching aircraft through the window of the tower cab, observed the incursion as it was happening and issued instructions for the aircraft to go around. The flight crew complied and, after receiving instructions to rejoin the approach, the aircraft landed uneventfully at 0025 Eastern Daylight Time.

1.0 FACTUAL INFORMATION

1.1 History of the occurrence

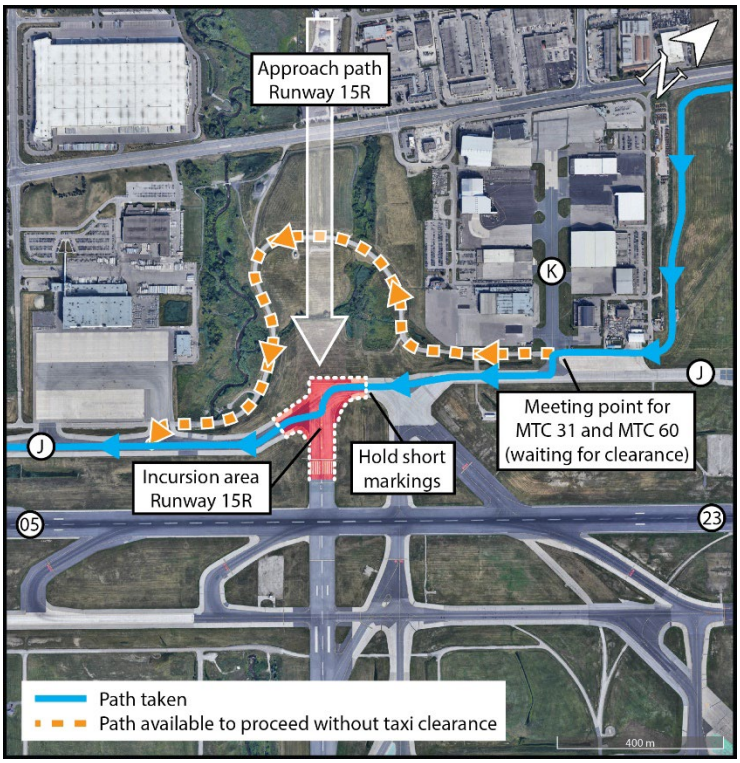
On 14 October 2022, a Greater Toronto Airports Authority (GTAA) airport painting crew consisting of 3 GTAA employees was preparing to complete runway painting tasks on Runway 05/23, west of Runway 15R at Toronto/Lester B. Pearson International Airport (CYYZ), Ontario. A NOTAM had been issued indicating that Runway 05/23 would be closed between the hours of 0000[1] and 0530 on 15 October 2022 as part of a regular runway maintenance program.

The crew would travel to the planned work area in 2 GTAA vehicles: the lead vehicle, driven by 1 crew member and carrying another, was designated Maintenance 31 (MTC 31); the 2nd vehicle, driven by the 3rd crew member, was designated Maintenance 60 (MTC 60). MTC 31 was towing a trailer carrying the equipment that would be used to complete the runway painting tasks.

The drivers of the 2 vehicles had arranged to meet shortly before midnight on the North Service Road, just east of Taxiway K.

MTC 31 arrived at approximately 2345, having entered the airside[2] of the airport at the Vista Cargo security checkpoint at the northeast corner of the airport, south of the threshold for Runway 23, and travelled on the North Service Road to the arranged meeting point. MTC 60 had entered the airside from a gate at the north end of the airport.

Figure 1. Maintenance 31's path (solid line) and the alternate route (dashed line) (Source: Google Earth, with TSB annotations)



Although the North Service Road would have allowed them to drive to a position west of Runway 15R without requiring a taxi clearance or crossing the runway, they instead planned a more direct route via Taxiway J (Figure 1). This

1 All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

2 Airside is "[t]he movement area of an airport, including adjacent terrain and buildings or portions thereof, where access is controlled." (Source: NAV CANADA, Terminav)

route would require a taxi clearance and clearance to cross the runway; however, it was frequently used by the drivers of MTC 31 and MTC 60, as well as other GTAA drivers.

After the construction NOTAM took effect at 0000, the driver of MTC 31 had to wait approximately 9 minutes to make his taxi request on the appropriate Toronto ground frequency (121.65 MHz), because the frequency was congested due to arriving and departing aircraft and other airport vehicles requesting and receiving clearances.

Approximately 90 seconds later, the ground controller replied and subsequently issued instructions for MTC 31 and MTC 60 to "proceed [to Taxiway] Juliet and hold short Runway one five right." This instruction was read back correctly by the driver of MTC 31. Both vehicles then proceeded west on Taxiway J with MTC 31 in the lead.

At 0013, the driver of MTC 31 approached the runway holding position marking for Runway 15R and slowed down, almost to a full stop, before proceeding onto the runway, in the displaced threshold area, without a clearance. The driver of MTC 60 did not follow him across the runway holding position marking, and held short of Runway 15R.

Shortly before the runway incursion, the tower controller had cleared the Air Canada Boeing 737 operating as flight ACA 174 to land on Runway 15R. He was watching the aircraft on approach through the tower cab window when he saw the maintenance vehicle entering the runway. The tower controller issued a go-around instruction to the aircraft when it was approximately 0.5 nautical miles from the runway. The flight crew performed the go-around and, during the manoeuvre, their altitude remained above 150 feet above ground level.

After issuing the go-around instruction, the tower controller contacted the ground controller and inquired whether he had authorized MTC 31 to cross the runway; he replied that he had not. The ground controller then instructed MTC 31 to clear the runway immediately, after which he instructed all maintenance and inspection vehicles to hold their positions while he assessed the situation. The ground controller resumed the issuance of taxi clearances after determining that it was safe to do so.

ACA 174 landed uneventfully on Runway 15R at 0025.

1.2 Injuries to persons

There were no injuries.

1.3 Damage to aircraft and maintenance vehicle

Neither the aircraft nor the maintenance vehicle was damaged.

1.4 Other damage

There was no other damage.

1.5 Personnel information

1.5.1 Driver of Maintenance 31

The driver of MTC 31 had been seasonally employed by the GTAA since 2013, first as a labourer and later as a specialist. He became a full-time employee in June 2017, when he started working as a painter. During the winter, the occurrence driver was involved with snow removal.

He obtained an Airside Vehicle Operator's Permit (AVOP) DA[3] in 2001, when he was employed with a tenant of the airport. He obtained an AVOP D[4] on 29 March 2016.

His AVOP D had been recertified on 03 March 2022.

The driver's shift on the night of the occurrence (from 2000 to 0600) was considered an overtime shift because it did not fall within the painting crew's regular work schedule.[5] For this shift, no supervisor was present, even though it was reported that the GTAA requires a supervisor or designate to be on site. The investigation was unable to determine why the painting crew was permitted to work on the airfield without a supervisor or designate on the night of the occurrence.

The occurrence driver did not hold a supervisory position with the GTAA and had not received training to be a supervisor, nor was he being compensated as one. Given he was driving the lead vehicle and operating the radio, and that he was the most senior and experienced member of the painting crew present for the shift, he assumed the role of de facto supervisor of the paint crew at the time of the occurrence.

1.5.2 Air traffic controllers

Two experienced controllers were on duty at the time of the occurrence, both of whom held the appropriate licence and were qualified for the operation in accordance with existing regulations. They had both begun their shift on 14 October 2022 at 2300, just over an hour before the runway incursion occurred. Due to the runway configuration in use, both controllers were seated in the tower cab and facing north, towards the thresholds for runways 15L and 15R.

It was determined that the actions of the controllers before, during, and after the event were conducted according to established procedures.

1.6 Aircraft information

Not applicable.

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3 See Section 1.17.1.1, *Airside Vehicle Operator's Permit* [AVOP] *Program*, for details about AVOP types.

4 Drivers operating ground vehicles on aircraft manoeuvring areas must hold the AVOP D, which is issued and enforced by the Greater Toronto Airports Authority (GTAA).

5 In this case, overtime describes a standard-length work period occurring on a scheduled day off, rather than an extension of the work period.

1.7 Meteorological information

The aerodrome routine meteorological report for CYYZ issued at 0000 (midnight), 13 minutes before the occurrence, indicated the following:

- Winds from 140° true, at 8 knots
- Visibility of 15 statute miles
- Few clouds at 10 000 feet above ground level
- Temperature 11 °C, dew point 6 °C
- Altimeter setting 29.87 inches of mercury

Weather was not considered to be a factor in this occurrence.

1.8 Aids to navigation

Not applicable.

1.9 Communications

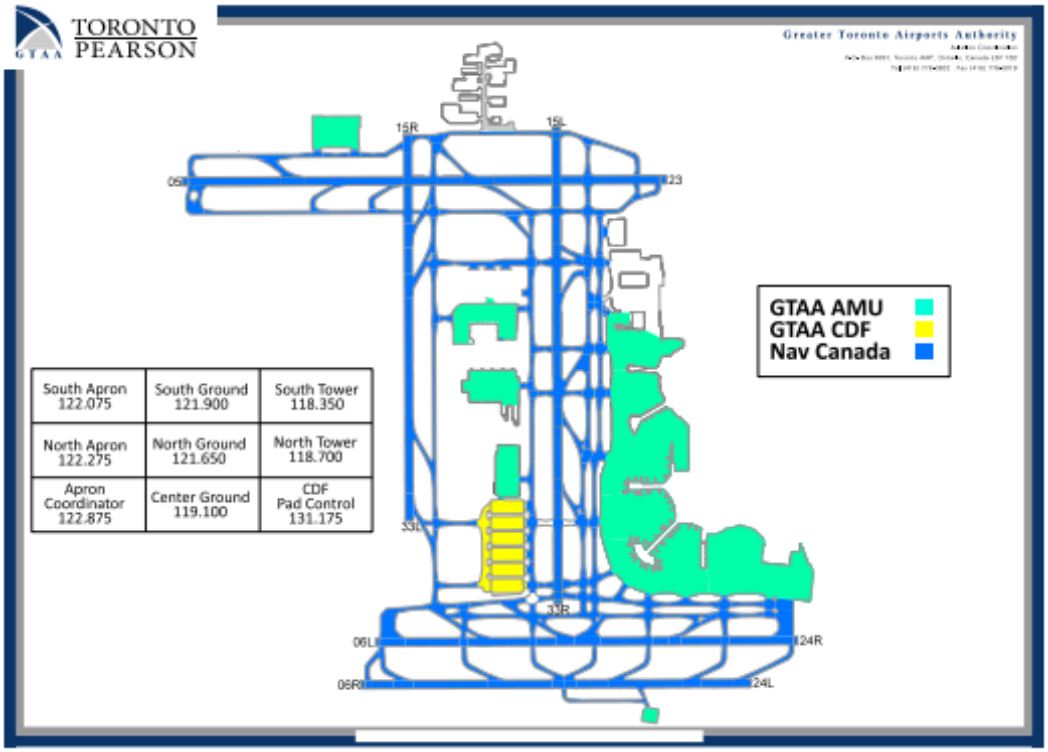
Drivers who possess an AVOP D are qualified to operate very high frequency (VHF) radios on aeronautical frequencies and hold the required Restricted Operator Certificate with Aeronautical Qualification. GTAA vehicles are equipped with VHF radios incorporating a handheld microphone with a push-to-talk switch.

1.10 Aerodrome information

CYYZ has been operated by the GTAA since 1996.

NAV CANADA is the provider of air and vehicle traffic services on the manoeuvring areas at the airport, while the GTAA provides these services for the Apron Management Unit (AMU) and the Central De-icing Facility (CDF) (Figure 2).

Figure 2. Air and vehicle traffic service providers at Toronto/Lester B. Pearson International Airport (Source: Greater Toronto Airports Authority, Airside Activity Program, Version 3.3 [2021], Appendix C, p. 26)



1.10.1 Runway holding position markings

The runway holding position markings on Taxiway J are painted markings that span the width of the taxiway, extending beyond the solid yellow taxiway boundary line. They are accompanied by a set of 2 flashing amber guard lights adjacent to the taxiway (Figure 3). There is also an illuminated sign on each side of the taxiway indicating the taxiway and runway identifiers (Figure 4). This configuration is less conspicuous than some of the other runway crossings at CYYZ that also incorporate stop-bar lighting.

Stop-bar lighting includes red elevated stop-bar lights adjacent to the hold position as well as a line of red lights set into the pavement across the taxiway, parallel to the runway holding position paint markings. They are controlled by air traffic control (ATC) and are most often used during low-visibility operations.

Figure 3. Taxiway J in the hours of darkness, approaching the hold-short line for Runway 15R, facing southwest (Source: Greater Toronto Airports Authority)

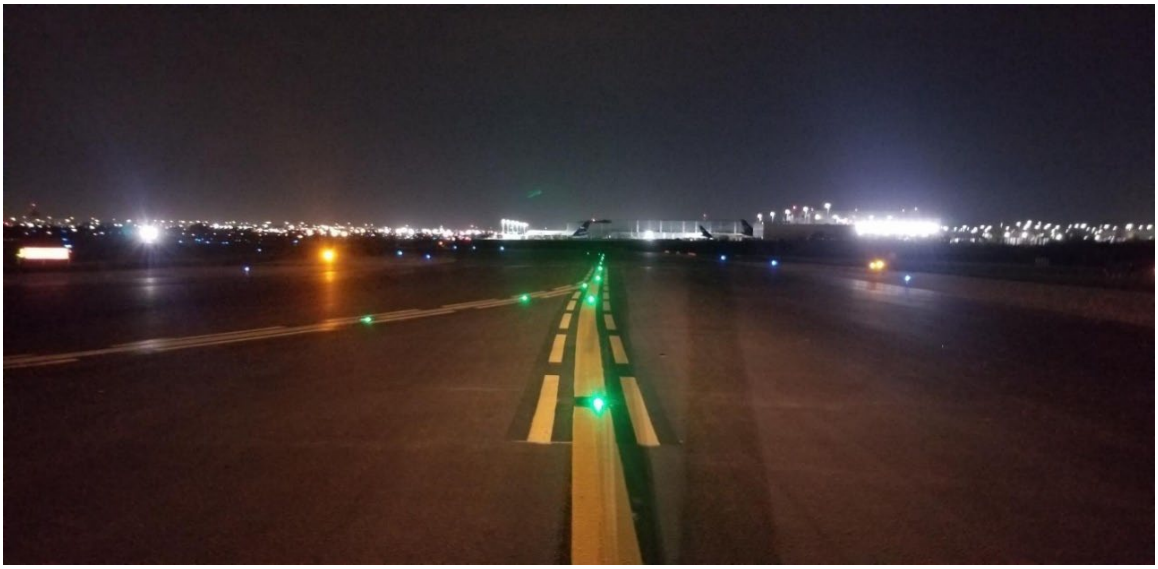
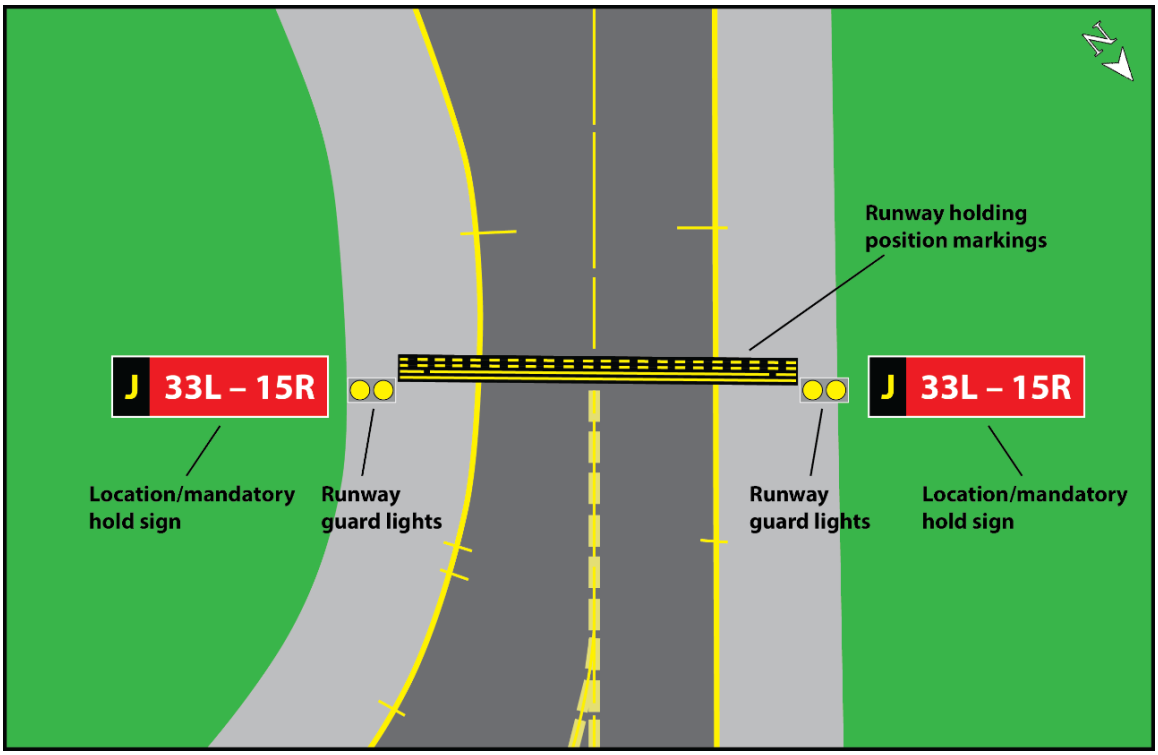


Figure 4. Diagram of the runway holding position markings at the intersection of Taxiway J and Runway 15R (Source: TSB)



1.10.2 Airside service roads

To keep airside vehicle traffic off of manoeuvring areas[6] and clear of runways and their associated obstacle limitation surfaces,[7] there are several service roads on the airport property. AVOP drivers are not required to obtain an ATC clearance to use service roads.

Most of the service roads at CYYZ are composed entirely of asphalt and are generally in good condition. To travel between the service roads at the north part of the airport and those at the south, a roadway for vehicular traffic, called the outer perimeter corridor, can be used. While the outer perimeter corridor does not require contact with ATC, it does require the crossing of 14 taxi-lanes, which connect the main apron to the taxiways. Given that vehicles are required to yield to aircraft at all times, using the outer perimeter corridor can be an inefficient and more stressful route for AVOP drivers, because increased vigilance is required to watch for and give way to all aircraft at these 14 taxi-lane crossings.

A commonly used route between the south and north sides of CYYZ is Taxiway F, which runs parallel to Runway 15R/33L. When the preferred east/west runways are in use, this taxiway is generally available for vehicle traffic, although it still requires a taxi clearance. In order to use Runway 15R/33L for landing and departing aircraft while vehicle traffic is present on Taxiway F, the arrivals and departures must be conducted under visual flight rules to adhere to considerations related to the obstacle limitation surface for the runway. Managing these requirements adds to an air traffic controller's workload.

Another commonly used route is to exit the airside of the airport and use public roads, allowing vehicles to travel between the south and north sides of the airport without the need for an ATC clearance or the use of the outer perimeter corridor. There are 3 points of access for airport vehicles entering the airside from the outside: 1 at the southeast corner of the airport, 1 near the northeast corner, and 1 in the mid-field area (in between the north/south runways), which is accessed from the southwest corner of the airport. These access points require drivers to pass through a security checkpoint.

1.11 Flight recorders

Not applicable.

1.12 Wreckage and impact information

Not applicable.

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6 The manoeuvring area is "that part of an aerodrome, other than an apron, that is intended to be used for the take-off and landing of aircraft and for the movement of aircraft associated with take-off and landing." (Source: Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, section 101.01)

7 An obstacle limitation surface is "a surface that establishes the limit to which objects may project into the airspace associated with an aerodrome consisting of the following; [*sic*] a takeoff surface, an approach surface, a transitional surface and an outer surface." (Source: Transport Canada, TP 1247E, *Aviation - Land Use in the Vicinity of Aerodromes*, 9th edition [2013/2014], Definitions, p. 6)

1.13 Medical and pathological information

During the 2 weeks before the occurrence, the driver of MTC 31 had worked 5 shifts, all of which were at night. The shift during which the occurrence took place was his 3rd consecutive night shift.

The driver reported that he had only slept for 3 hours on the morning of 14 October 2022, although he normally slept for 6 to 8 hours after a night shift. As a result, some risk factors for fatigue existed, notably an acute lack of sleep during the rest period immediately before the occurrence shift. However, this information alone is not sufficient to conclude whether fatigue contributed to the occurrence, which took place less than halfway through the driver's shift.

1.14 Fire

Not applicable.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

1.16.1 TSB laboratory reports

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

- LP095/2022 – Flight Data Analysis

1.17 Organizational and management information

1.17.1 Greater Toronto Airports Authority

1.17.1.1 Airside Vehicle Operator's Permit Program

As stated in the GTAA's *Airport Traffic Directives – AVOP Requirements and Administration 2019*,

> [t]he Airside Vehicle Operator's Permit (AVOP) Program establishes the standards by which vehicles operating airside at Toronto Pearson International Airport must be operated, equipped, and marked.[8]

The AVOP Program is described in this manual, which outlines permit application and renewal procedures, vehicle requirements, and the program's enforcement, including infractions and the appeal process.

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8 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP Requirements and Administration 2019* (08 January 2019), p. 9.

The GTAA issues 2 types of AVOPs:

- AVOP DA - permits drivers to operate vehicles on the airside surfaces of the airport, including aprons, uncontrolled taxiways, and service roads.
- AVOP D - includes the privileges of the AVOP DA while also permitting drivers to operate on taxiways and runways. There is no minimum experience required before a driver can upgrade from an AVOP DA to an AVOP D.

To present its directives as they relate to the DA and D permits, the GTAA has published, respectively, *Airport Traffic Directives – AVOP DA 2019*[9] and *Airport Traffic Directives – AVOP D 2019*.[10] The former describes airside surfaces, general safety practices for these areas, and the visual aids used on aprons, service roads, and uncontrolled taxiways, while the latter explains CYYZ's radiotelephone protocols and the visual aids used on taxiways and runways.

Together, the 3 manuals form the GTAA's airport traffic directives. They are publicly available on the GTAA's AVOP website.[11]

1.17.1.2 Airside Vehicle Operator's Permit training

Training for each permit includes classroom training, a written exam, and practical training with a GTAA–approved instructor. Airport tenants can be authorized by the GTAA to conduct some or all of the training in-house using their own personnel.

AVOP drivers are required to re-certify every 3 years by completing a written exam and a practical evaluation.

Drivers must also obtain a Restricted Operator Certificate with Aeronautical Qualification from Innovation, Science and Economic Development Canada to exercise the privileges of the AVOP D. This certificate is required for operators of radiotelephone equipment so that they will be able to transmit on aeronautical VHF frequencies, which are used for communications with ATC on the published ground and apron frequencies.

There are many airside jobs that require the AVOP D, including but not limited to, airport maintenance, aircraft towing, aircraft rescue and firefighting, and wildlife control. It is important to note that for a majority of AVOP D holders, the role of airside driver is not their primary role—it is simply a means for them to have access to and move around the airside.

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9 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP DA 2019* (08 January 2019).

10 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP D 2019* (08 January 2019).

11 Toronto Pearson, torontopearson.com/en/airport-employees/passes-and-permits/airside-vehicle-operators-permits (last accessed on 13 December 2023).

1.17.1.3 Airport traffic directives

1.17.1.3.1 Use of service roads

Airport Traffic Directives – AVOP DA 2019 states that "[v]ehicle operators shall use service and outer perimeter roads to reach field locations when these roads are available."[12]

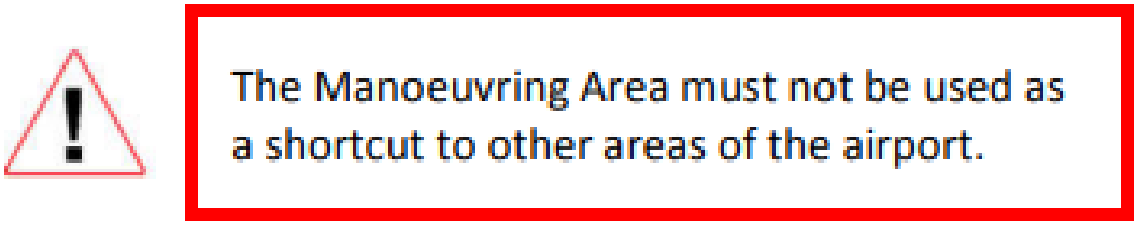
The investigation did not find any records of enforcement action related to this specific directive.

The AVOP D manual directs the following:

> Ensure Need and Right
>
> Use service roads whenever possible to minimize time spent on taxiways and runways.[13]

The introduction of this manual also includes a caution message box that warns against the use of the manoeuvring area as a shortcut (Figure 5).

Figure 5. Caution message box in the airport traffic directives (Source: Greater Toronto Airports Authority, Airport Traffic Directives – AVOP D 2019 [08 January 2019], Section 2.1: Introduction, p. 9)



Neither of the training presentations in use at the time of the occurrence, for either AVOP DA or AVOP D applicants, mentioned the directives relating to the use of service roads and connecting corridors. It could not be determined whether these directives were consistently discussed during practical training.

1.17.1.3.2 Runway crossings

In addition to the requirement for explicit authorization to cross a runway, whether or not it is active, the airport traffic directives require drivers to "[…] visually check that proceeding as permitted will not cause interference with any aircraft."[14] In the AVOP D manual, drivers are directed to "[…] visually check to ensure that there is no conflicting traffic."[15]

Neither of the GTAA training presentations in use at the time of the occurrence, for either AVOP DA or AVOP D applicants, contained guidance related to runway crossing safety

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12 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP DA 2019* (08 January 2019), Section 3.3.1: Airside Service Roads, p. 27.

13 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP D 2019* (08 January 2019), Section 3.6: Runway Safety, p. 27.

14 Ibid., Section 3.4: Crossing a Runway, p. 25.

15 Ibid., Section 3.6: Runway Safety, p. 28.

measures or best practices. Furthermore, no procedures specific to runway crossings are required by the airport traffic directives or introduced in the training materials. It could not be determined whether this type of guidance is commonly discussed during practical training.

By contrast, guidance available to pilots suggests that they exercise additional caution, including the use of specific procedures when taxiing across runways to prevent incursions. These procedures include a visual check in each direction, the use of all available lights to make the aircraft as conspicuous as possible, and maintaining a sterile cockpit[16] during taxi.[17]

1.17.1.4 Previous TSB investigation

During the TSB investigation into a May 2019 collision between a fuel tanker truck and a Jazz Aviation LP Dash 8 aircraft at CYYZ, the airport traffic directive requiring drivers to use "service and outer perimeter roads to reach field locations when these roads are available"[18] was referenced in light of the fact that the fuel tanker driver had not used the available outer perimeter corridor on his way to his parking area at the south end of CYYZ. The report included the following finding as to risk:

> If vehicle operators do not follow airport traffic directives with regard to vehicle corridors, there is a higher potential for traffic conflicts, increasing the risk of ground collisions.[19]

1.17.1.4.1 Previous safety action indicated

In Section 4.1 *Safety action taken* in the above-mentioned report, which was released in September 2020, it is stated that

> […] the GTAA has initiated a review of the entire Airside Vehicle Operator Permit (AVOP) program, with the input of industry partners, including observations from both new and experienced AVOP drivers as well as other airside personnel.[20]

At the time of the 15 October 2022 occurrence, the most recent revision of the GTAA's airport traffic directives was the same version that was in effect during the May 2019 occurrence. It had been issued on 08 January 2019.

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16 A sterile cockpit is "[a]ny period of time when the flight crew should not be disturbed, except for matters critical to the safe operation of the aircraft. Disturbances may include, but not be limited to, calls received from non-operations areas (e.g. company), entry onto the flight deck by cabin crew, and extraneous conversations not related to the current phase of flight." (Source: International Civil Aviation Organization, Doc 9870, *Manual on the Prevention of Runway Incursions*, First Edition [2007], Appendix B-4: Best Practices on the Flight Deck, section 6.3: Taxi best practices, paragraph 6.3.8.)

17 Ibid., Appendix B-4: Best Practices on the Flight Deck, section 6.3: Taxi best practices.

18 Greater Toronto Airports Authority, *Airport Traffic Directives – AVOP DA 2019* (08 January 2019), Section 3.3.1: Airside Service Roads, p. 27.

19 TSB Air Transportation Safety Investigation Report A19O0063.

20 Ibid., section 4.1: Safety action taken.

On 22 March 2023, the GTAA issued an update to the airport traffic directives, replacing the 2019 version of the document. This update did not include changes related to the finding made in the above-mentioned TSB investigation report into the May 2019 occurrence, and there is no indication of changes in enforcement, training, or awareness regarding the use of service roads.

1.17.1.5 Preferred runways at CYYZ

Due to a variety of factors, including operational efficiency and noise abatement, the east/west runways are the preferred runways at CYYZ[21] for daytime operations. Factors such as wind strength and direction, surface contamination, and construction activity can necessitate a change to a north/south configuration, although this is relatively uncommon.

As part of its noise management action plan, the GTAA has implemented a nighttime preferential runway system, which outlines the preferred runways to be used between midnight and 0630.[22] The primary goal of the system is to reduce the noise over residential communities. According to the GTAA, Runway 15R is not a primary option, for either arrivals or departures, in any of the configurations described in the nighttime preferential runway system, and in keeping with this, Runway 15R is not commonly used for nighttime arrivals. However, owing to previous inclement weather, the flow of traffic, and thunderstorms in the area, Runway 15R was in use at the time of the occurrence.

1.17.2 NAV CANADA

NAV CANADA is a not-for-profit corporation that operates Canada's civil air navigation system and provides ATC for all controlled airspace in Canada, as well as control services for the manoeuvring areas at controlled airports, including issuing taxi clearances to ground vehicles.

1.17.2.1 Airport vehicles

While NAV CANADA controllers do have the authority to refuse requests for taxi clearances from ground vehicles if the traffic volume is too high to safely accommodate them, they are not mandated to validate the drivers' need to use the taxiways.

1.18 Additional information

1.18.1 Human factors

1.18.1.1 Attention

While driving from the meeting point to the worksite, the driver of MTC 31 was occupied with several tasks: driving his own vehicle with a trailer, leading a 2nd vehicle, and mentally

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21 Toronto Pearson, torontopearson.com/en/community/noise-management/understanding-airport-noise/runways (last accessed on 13 December 2023).

22 Toronto Pearson, torontopearson.com/en/community/get-involved/community-conversations/trial-of-an-updated-nighttime-preferential-runway-system (last accessed on 13 December 2023).

preparing for the painting tasks that his team would be completing during their shift. At the time, he had assumed the role of de facto supervisor, which resulted in a level of self-imposed pressure to execute the painting tasks to a high standard.

1.18.1.2 Expectation

While driving on the manoeuvring area, ground vehicle drivers are expected both to obey clearances and hold-short instructions and to yield to aircraft at all times. Signs, lights, and runway holding position markings indicate to drivers that they are about to cross a runway and may prompt them to visually scan the crossing before proceeding. Explicit ATC clearance is required to enter or cross any runway.

Runway 15R is among the least common runways used for landings at CYYZ, in part due to weather patterns and existing runway selection criteria as described in Section 1.17.1.5 *Preferred runways at CYYZ*. Runway 15R is also the least equipped for low-visibility operations. In addition, according to the GTAA's nighttime preferential runway system, Runway 15L is the preferred arrival runway in every situation where landing southbound is warranted.[23] These factors could lead to an expectation that Runway 15R would not likely be in use for landing at any given time.

The driver of MTC 31, who had more than 6 years of experience operating maintenance vehicles at the airport, had formed a mental model reflecting his understanding of the airport's working environment. His expectation that Runway 15R would be unlikely to be used for arriving aircraft at that time of night aligned with his previous experience. Given that he was focused on preparing for the painting task, his well-established mental model of the environment led to his driving actions being carried out almost automatically.

When performing a routine task such as driving, it is possible for a person to complete that task automatically while focusing their conscious attention elsewhere. This phenomenon is called automaticity.[24]

1.18.2 TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

The risk of collisions from runway incursions is a Watchlist 2022 issue. As this occurrence demonstrates, a lapse in attention by even an experienced airport maintenance vehicle driver can result in a runway incursion with a landing aircraft in close proximity.

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23 Ibid.

24 T. Wheatley and D. M. Wegner, "Automaticity of Action, Psychology of" in *International Encyclopedia of the Social & Behavioral Sciences* (2001), 2. Conscious Automaticity, at scholar.harvard.edu/dwegner/files/wheatleywegner.pdf (last accessed on 13 December 2023).

ACTION REQUIRED

Risk of collisions from runway incursions will remain on the TSB Watchlist until

- effective defences to prevent runway incursions are implemented in incursion hotspots; or
- the rate of runway incursions demonstrates a sustained reduction, and the number of high-risk incursions continues to show a sustained reduction.

Reducing the risk of runway incursions is a complex issue and requires collaboration from all sectors of the air transportation industry. There is no single solution that will reduce the risk of runway incursions nationwide. Rather, solutions tailored for each airport, in combination with wider-reaching technological advancements such as in-cockpit situational awareness aids and runway status lights, may be more effective.

2.0 ANALYSIS

The investigation determined that the actions of the air traffic controllers and the flight crew of the approaching aircraft before, during, and after the incursion were carried out in accordance with established procedures and did not contribute to the runway incursion.

The analysis will focus on identifying the factors that led to the incursion, notably the human factors issues that influenced the actions of the maintenance vehicle driver in the occurrence. The implementation and interpretation of the airport traffic directives, published by the Greater Toronto Airports Authority (GTAA), as they relate to the use of service roads, will also be examined, as will the procedures related to runway crossings in the Airside Vehicle Operator's Permit (AVOP) Program.

2.1 Human factors

2.1.1 Attention

On the night of the occurrence, the attention of the driver of the vehicle designated as Maintenance 31 was split between the tasks of driving the vehicle with a trailer on the manoeuvring area of Toronto/Lester B. Pearson International Airport (CYYZ), leading a 2nd vehicle, and mentally preparing for the painting tasks that his team would be completing during their shift. In addition, the driver had assumed the role of de facto supervisor, which resulted in self-imposed pressure to ensure that the work was completed on time and to a high standard. Given the fact that he was less familiar with the supervisory role than with the driving task, his attention was likely focused on the planning and execution of the former, and diverted from the latter. This resulted in a reliance on past experience for the driving task, allowing for a level of automaticity to take over.

Finding as to causes and contributing factors

The occurrence driver's attention was split between his driving duties and the planning of the upcoming painting tasks that he would be supervising. As a result, he was paying less attention to monitoring the route for hazards.

2.1.2 Expectation

The driver had significant experience driving on the manoeuvring areas at CYYZ. Although there was more traffic than usual on the night of the occurrence, in his experience there would normally be minimal air traffic arriving due to the time of night.

In addition, the driver's familiarity with runway usage at CYYZ, informed by his years of experience driving at the airport, led him to expect that it would be unusual for aircraft to be landing on Runway 15R.

Finding as to causes and contributing factors

Because the driver had crossed Runway 15R at the displaced threshold many times without stopping, the mental model he developed did not include stopping at the holding position, even though he read back the instruction to stop.

2.2 Greater Toronto Airports Authority airport traffic directives

2.2.1 Use of service roads

According to the GTAA's airport traffic directives, the service roads shall be used when available. However, the occurrence driver requested clearance to use the taxiway to cross Runway 15R instead of the available North Service Road, which was a normal practice among AVOP drivers working for the GTAA because this route is more direct than that afforded by the service road.

Finding as to causes and contributing factors

Although contrary to the GTAA's *Airport Traffic Directives*, drivers normally used the manoeuvring areas as opposed to the North Service Road because these areas are perceived to be quicker given the typical runway operations on the east/west runways.

Although the airport traffic directives specifically instruct vehicle operators to use service and outer perimeter roads, when available, to arrive at field locations, there is no indication that this directive is followed during everyday operations or if any emphasis is placed on this directive either through training or enforcement. Records did not indicate any instance in which an AVOP driver had been issued an infraction for not using the service roads when they were available.

While the existence of the service roads suggests their purpose, the airport traffic directives do not elaborate on this purpose or on the benefits of using these roads, which include a reduction in congestion on both the very high frequency (VHF) ground frequency and the manoeuvring areas of the airport, resulting in a higher level of safety for aircraft operations.

Finding as to risk

If airport traffic directives that require the use of service roads where possible are not emphasized through either AVOP training or enforcement, there is a risk that vehicle operators will use aircraft manoeuvring areas when other options exist, increasing the risk of runway incursions or collisions.

2.2.2 Runway crossings

While guidance and procedures meant to aid in the prevention of runway incursions are widely available to pilots, AVOP drivers at CYYZ—who use the same taxiways and runways—are not provided with similar guidance or procedures.

Finding as to risk

If airport vehicle drivers are not given specific procedures to follow when crossing runways, there is an increased risk of runway incursions or collisions.

2.2.3 Runway holding position markings

Although the runway holding position markings at the intersection where the runway incursion took place met regulatory requirements, they were less conspicuous than other holding position markings as they did not incorporate inset or elevated stop-bar lighting.

Finding as to causes and contributing factors

Given the driver's split attention, the visual cues that were available to designate the holding position were not salient enough to alter his mental model and stop him from entering the runway. The result was a runway incursion and a risk of collision with the aircraft on approach.

3.0 FINDINGS

3.1 Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. The occurrence driver's attention was split between his driving duties and the planning of the upcoming painting tasks that he would be supervising. As a result, he was paying less attention to monitoring the route for hazards.

2. Because the driver had crossed Runway 15R at the displaced threshold many times without stopping, the mental model he developed did not include stopping at the holding position, even though he read back the instruction to stop.

3. Although contrary to the Greater Toronto Airports Authority's *Airport Traffic Directives*, drivers normally used the manoeuvring areas as opposed to the North Service Road because these areas are perceived to be quicker given the typical runway operations on the east/west runways.

4. Given the driver's split attention, the visual cues that were available to designate the holding position were not salient enough to alter his mental model and stop him from entering the runway. The result was a runway incursion and a risk of collision with the aircraft on approach.

3.2 Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

1. If airport traffic directives that require the use of service roads where possible are not emphasized through either Airside Vehicle Operator's Permit training or enforcement, there is a risk that vehicle operators will use aircraft manoeuvring areas when other options exist, increasing the risk of runway incursions or collisions.

2. If airport vehicle drivers are not given specific procedures to follow when crossing runways, there is an increased risk of runway incursions or collisions.

4.0 SAFETY ACTION

4.1 Safety action taken

The Board is not aware of any safety action taken following this occurrence.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 06 December 2023. It was officially released on 20 December 2023.