Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AIR TRANSPORTATION SAFETY INVESTIGATION REPORT A18P0177

RUNWAY INCURSION AND RISK OF COLLISION

Pacific Coastal Airlines Ltd., Beechcraft 1900C, C-GIPC
and
City of Trail airport vehicle (Chevrolet Silverado 1500)
Trail Airport, British Columbia
12 December 2018

Canada

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Summary

On 12 December 2018, a Pacific Coastal Airlines Ltd. Beechcraft 1900C aircraft (registration C-GIPC, serial number UC 110), operating as flight PCO451, was on a scheduled flight from Vancouver International Airport (CYVR), British Columbia (BC), to Trail Airport (CAD4), BC, with 2 flight crew members and 19 passengers on board. While the aircraft was conducting an approach to land southbound on Runway 16, an airport vehicle was travelling northbound on the runway, performing a runway inspection. When the aircraft touched down, the airport vehicle was still on the runway. The airport vehicle exited the runway onto the taxiway before the aircraft reached the runway/taxiway intersection, avoiding a collision. Radio communications had not been established between the aircraft and the airport vehicle. There were no injuries, and there was no damage to the aircraft.

1.0 FACTUAL INFORMATION

The International Civil Aviation Organization (ICAO) and Transport Canada (TC) define a runway incursion as

> [a]ny occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.[1,2]

The Transportation Safety Board of Canada (TSB) defines a risk of collision as

> a situation in which an aircraft comes so close to being involved in a collision that a threat to the safety of any person, property or the environment exists.[3]

1.1 History of the occurrence

On 12 December 2018, at approximately 0630,[4] an airport vehicle operator (Operator 1) arrived at Trail Airport (CAD4), BC, to find that the runway was covered in slushy snow that had frozen overnight. A second airport vehicle operator (Operator 2) was called in to assist with snow removal; he arrived at the airport at 0700. Shortly afterward, both vehicle operators began snow removal. Operator 1 was driving a truck and Operator 2 was driving a snowplow.

A Pacific Coastal Airlines Ltd. Beechcraft 1900C aircraft (registration C-GIPC, serial number UC 110), operating as flight PCO451, was conducting an instrument flight rules (IFR) flight from Vancouver International Airport (CYVR), BC, to CAD4. The flight was scheduled to depart CYVR at 0915 with 2 flight crew members and 19 passengers on board. However, the departure was delayed because the runway conditions at CAD4 were reported as poor.

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1 International Civil Aviation Organization, Doc 9870 AN/463, *Manual on the Prevention of Runway Incursions*, First Edition (2007), Chapter 1, section 1.1, p. 1-1.

2 Transport Canada, TP 14371, *Transport Canada Aeronautical Information Manual* (TC AIM), GEN – General (11 October 2018), section 5.1.

3 Canadian Transportation Accident Investigation and Safety Board, SOR-2018-258, *Transportation Safety Board Regulations*, subsection 2(6).

4 All times are Pacific Standard Time (Coordinated Universal Time minus 8 hours).

Runway conditions at CAD4 had been filed electronically in an Aircraft Movement Surface Condition Report (AMSCR)[5] from a laptop on board one of the airport vehicles[6] to the NAV CANADA web-based application SNOWiz.[7] The truck driver filed an AMSCR at 0655 and an updated AMSCR at 1009.

After the flight crew received the updated AMSCR information, the flight departed CYVR at 1021. Its estimated time of arrival at CAD4 was 1123.

When the aircraft was at 12 500 feet, on descent into CAD4, the weather became suitable for visual flight rules (VFR) flight. At 1114, when the aircraft was approximately 21 nautical miles (NM) from CAD4, the flight crew cancelled IFR and continued heading east under VFR, over the city of Trail, which is northeast of CAD4.

At 1117, the snowplow driver stopped at the runway holding position marking for Runway 16/34 (Figure 1). He used the mandatory frequency (MF) to contact the flight crew, requesting the aircraft's arrival time. The flight crew responded that its estimated time of arrival was in 5 minutes. The snowplow driver informed the flight crew that he would be on the runway to remove an area of slush near the intersection with the taxiway. The flight crew acknowledged this communication, and the snowplow driver entered the runway moments later.

Approximately 30 seconds after the snowplow entered the runway, the truck driver entered the runway via the taxiway without confirming the aircraft's location or stopping at the runway holding position marking. The truck driver reported making a call on the MF indicating that he was entering the runway; however, the flight crew did not hear the radio call. The truck driver then proceeded north on Runway 16.

The snowplow driver observed the truck driving north on the runway and made a call on the MF to inform the truck driver that the aircraft was expected to land in approximately 3 minutes. The truck driver did not respond to this call, and the flight crew did not hear the attempted communication. The snowplow driver turned his focus back to snow-removal activities and, after turning in the opposite direction, lost track of the truck.

At 1118, the snowplow driver exited the runway and reported on the MF that he was clear of the runway. The flight crew received and acknowledged this communication.

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5 According to the *Transport Canada Aeronautical Information Manual* (TC AIM), "AMSCRs are issued to alert pilots of natural surface contaminants—such as snow, ice or slush—that could affect aircraft braking performance. The RSC [runway surface condition] section of the report provides information about runway condition in plain language, while the CRFI [Canadian Runway Friction Index] section describes braking action quantitatively using the numerical format described in AIR 1.6.3." (Transport Canada TP 14371 (11 October 2018), AIR – Airmanship, section 1.6.4)

6 Airport vehicle operators can input the runway surface conditions into the AMSCR form using an on-board laptop via a touch screen and drop-down menus, and then file and transmit the AMSCR form directly to the SNOWiz application.

7 NAV CANADA, "Aeronautical Information Submissions," at http://www.navcanada.ca/EN/products-and-services/Pages/aeronautical-information-submissions.aspx (last accessed 07 February 2020).

After the truck driver reached the threshold of Runway 16, he turned and continued south on the runway toward the threshold of Runway 34 The truck driver needed extra time at the threshold of Runway 34 to inspect ridges on the runway surface and to provide an updated AMSCR, but he did not broadcast his intentions.

While the aircraft was on its final approach, 4 NM from the airport, the flight crew reportedly called on the MF to indicate that they would be landing in 1 minute. Neither driver heard the radio call. Just before the aircraft landed, the flight crew conducted a visual scan of the runway and observed the snowplow on the apron.

After completing the inspection at the threshold of Runway 34, the truck driver turned his vehicle northbound at 1121:45 and drove along the east side of the runway.

At 1122:21, the aircraft touched down on Runway 16 at a speed of 113 knots. Immediately after touching down, the flight crew applied initial reverse to begin slowing the aircraft. As the crew looked down the runway, they observed the truck on the runway and applied full reverse and maximum braking. The aircraft began to skid as a result of the heavy braking; however, the crew was able to maintain control.

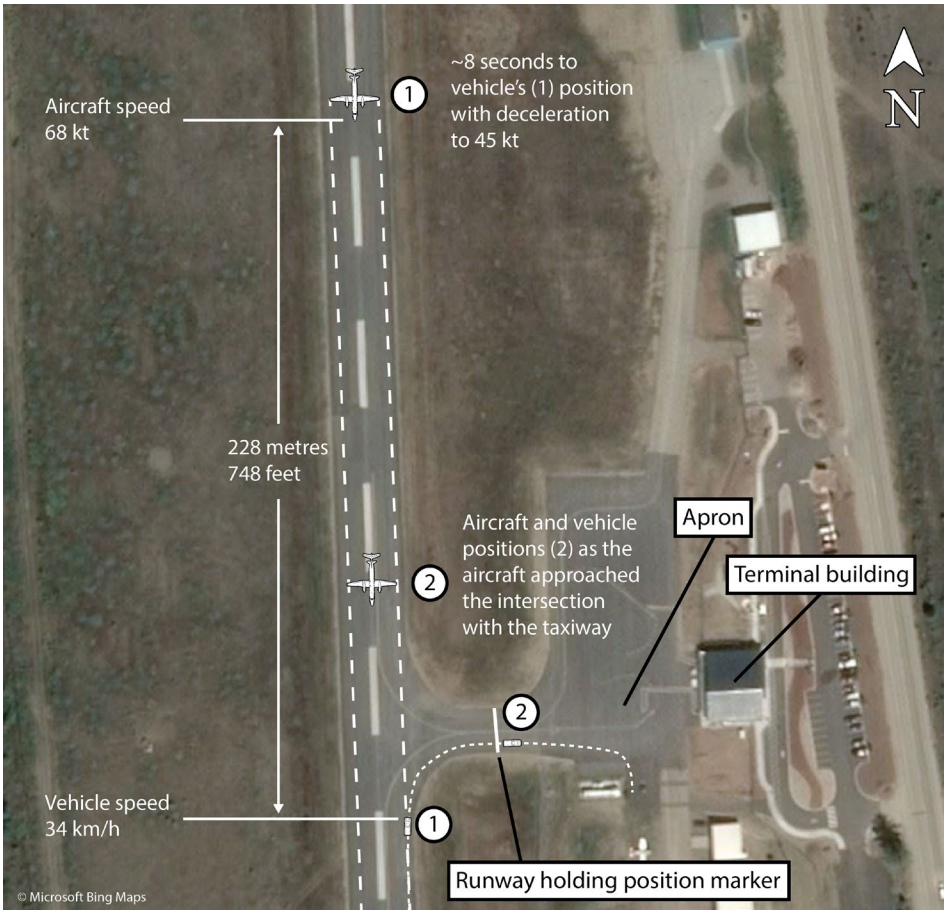
Upon seeing the landing aircraft, the truck driver accelerated in an effort to reach the taxiway and exit the runway. He was able to do so before the aircraft reached the intersection with the taxiway.

After passing the taxiway intersection, the aircraft rolled to a stop and turned around on the runway to take the taxiway to the apron, without further incident.

During this occurrence, the aircraft and the truck had come within 228 m of each other (Figure 1). The aircraft passed the taxiway intersection approximately 4 seconds after the truck entered the taxiway.

After Operator 1 had parked his truck beside the apron, he discovered that the volume on the vehicle’s very high frequency (VHF) 2-way radio had been turned down to an inaudible level.

Figure 1. Aircraft and vehicle positions when the aircraft was applying full reverse (1) and as it approached the intersection with the taxiway (2) (Source: Microsoft Bing Maps, with TSB annotations)



1.2 Injuries to persons

Not applicable.

1.3 Damage to aircraft

There was no damage to aircraft.

1.4 Other damage

Not applicable.

1.5 Personnel information

1.5.1 Flight crew

The 2 flight crew members — the captain and the first officer — were licensed, qualified, and trained for the flight (Table 1). The crew members were adequately rested, and fatigue was not considered a factor in this occurrence.

The flight crew members both held a Radio Operator Certificate with Aeronautical Qualification (ROC-A).[8] Training for an ROC-A involves radio operating procedures, radio terminology, and emergency communications. The certificate does not expire, and no revalidation is required.

Table 1. Flight crew information

	Captain	First officer
Pilot licence	Airline transport pilot licence (ATPL)	Commercial pilot licence (CPL)
Total flying hours	2474	1882
Flight hours on type	1398	332
Flight hours in the last 7 days	15.9	14.3
Flight hours in the last 30 days	71	52
Flight hours in the last 90 days	240	127
Flight hours on type in the last 90 days	240	127
Hours on duty before the occurrence	4	4
Hours off duty before the work period	11	11

1.5.2 Ground personnel

Operator 1 had been employed as an airport maintenance technician at CAD4 for 14 months. Before taking this position, he had had no airport operations experience.

Operator 2 had been employed at CAD4 for 12 years. Since 2014, he had been employed as an airport operation specialist. Before taking this position, he had had no airport operations experience.

Operator 1 and Operator 2 each possessed a valid Unrestricted Airport Vehicle Operator's Permit (U -AVOP)[9] issued by the airport manager. They had both also completed the ROC-A training and possessed a valid certificate. Airport staff do not require regulatory certification for their job functions.

Operator 1 and Operator 2 were adequately rested, and fatigue was not considered a factor in this occurrence.

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8 According to the Industry Canada *Study Guide for the Restricted Operator Certificate with Aeronautical Qualification*, the Radio Operator Certificate with Aeronautical Qualification (ROC-A) is issued by Industry Canada and "is required by operators of radiotelephone equipment on board aircraft and at aeronautical land (fixed and mobile) radio stations using aeronautical mobile frequencies." (Source: Industry Canada publication RIC-21, Issue 3 [February 2010])

9 According to the City of Trail *Airport Operations Manual*, a U-AVOP is " a document issued by the airport manager certifying that the person named therein is authorized to operate vehicles on all airside areas." City of Trail, *Airport Operations Manual*, Appendix F – *Airport Vehicle Operator Permit (AVOP) Study Guide* (effective date 01 April 2017), p. 6.

Airports are required to establish a training program for employees to ensure they are appropriately trained for the tasks they are assigned.[10,11] At CAD4, airport staff have a lengthy list of responsibilities. To support the staff in these duties, the *Airport Staff Training Manual*[12] was developed. At the time of the occurrence, the *Airport Staff Training Manual* contained 67 training items. Operator 1 had completed 36, or 54%, of these items, and Operator 2 had completed 38, or 57%. One of the 67 items that neither operator had completed was a review of TC Advisory Circular (AC) *302-003: Personnel and Equipment within the Critical Portion of the Runway Strip*[13].

1.6 Aircraft and vehicle information

1.6.1 Aircraft

The Beechcraft 1900C is a 19-seat aircraft powered by 2 Pratt & Whitney Canada PT6A-65B turboprop engines. Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations. The investigation found no indication that there was any aircraft system malfunction during the occurrence.

1.6.2 Vehicles

1.6.2.1 Airport fleet

CAD4 has a fleet of vehicles used for various maintenance activities (Table 2). Initial training on how to operate the vehicles is provided to operators when they are hired, and the training is reviewed during a winter operations meeting held before each winter season. Vehicle operators decide which equipment to use for each task they are performing.

Table 2. Trail Airport vehicle fleet at January 2019

Vehicle	Colour	2-way VHF radio
Airport tractor	Green	Hand-held
Snowplow 1	White	Mounted
Snowplow 2	Green	Hand-held
Skid steer*	Yellow	Hand-held
Airport 1 (truck)	White	Mounted
Airport 2 (truck)	White	Mounted

* A small highly manoeuvrable vehicle with a large bucket used for loading.

10 Transport Canada, SOR/96-433, *Canadian Aviation Regulations* (CARs), paragraph 302.07(1)(*g*).

11 Transport Canada, TP 312, *Aerodromes Standards and Recommended Practices*, 5th edition (effective date 15 September 2015), paragraph 8.5.1.5, p. 299.

12 City of Trail, *Airport Staff Training Manual* (effective date 27 May 2017).

13 Transport Canada, Advisory Circular (AC) No. 302-003, *Personnel and Equipment Within the Critical Portion of the Runway Strip*, Issue 02 (28 January 2009).

Operator 1 was driving Airport 2, a 2011 Chevrolet Silverado 1500, in this occurrence. Operator 2 was driving Snowplow 1, a 2012 International 7400 SBA 4x2.

1.6.2.2 Airport Vehicle Operator Permit

The ICAO *Manual on the Prevention of Runway Incursions* recommends the following:

> As a result of local hazard analyses in Europe in 2001, the operation of vehicles on the aerodrome has been highlighted as a potentially high-risk activity which demands that a number of formal control measures be put in place to manage the risk. A vehicle driver training programme is one of these control measures and should form part of the overall safety management system of the aerodrome operator.[14]

The policies and procedures regarding the operation of vehicles at CAD4 are described in its *Airport Vehicle Operator Permit (AVOP) Study Guide*. To obtain an AVOP, candidates are required to complete a written exam and peer training with an experienced employee. At the time of the occurrence, there was no set duration or curriculum for the peer training.

The AVOP Study Guide describes the procedure to follow before proceeding onto the manoeuvring area:

> Before proceeding on to maneuvering areas the vehicle operator shall hold short and visually check for arriving and departing aircraft. The operator shall then broadcast his/her intentions on the ATF [aerodrome traffic frequency] frequency. The vehicle may proceed onto the maneuvering area only if there is no indication of arriving or departing aircraft. Vehicle operator shall re-broadcast intentions when changing locations.[15]

The airport procedures state that airport vehicles are to be inspected daily to ensure that they are mechanically sound and functioning as intended.[16] However, the daily airport vehicle inspection had not been completed on the occurrence vehicle on the day of the occurrence.

1.6.2.3 Radios

The occurrence vehicle was equipped with a functioning VHF radio capable of 2-way communication with aircraft and other airport vehicles. The AVOP Study Guide states that "[e]ach operator shall ensure that the two-way radio is working before the vehicle enters the airport maneuvering area."[17]

Although the 2-way radio had been used in the morning on the day of the occurrence, it was not confirmed to be working before the vehicle entered the airport manoeuvring area when

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14 International Civil Aviation Organization, Doc 9870 AN/463, *Manual on the Prevention of Runway Incursions*, First Edition (2007), Appendix D, Airside Driving Vehicle Best Practices, Introduction, 1.2.

15 City of Trail, *Airport Operations Manual*, Appendix F – *Airport Vehicle Operator Permit (AVOP) Study Guide* (effective date 01 April 2017), p. 10.

16 Trail Regional Airport, *Standard Operating Procedure SOP001-Daily Airside Inspections – Runway*, approved 01 January 2018.

17 Ibid., p. 9.

the incursion occurred. At the time of the occurrence, the volume on the radio was at an inaudible level. The investigation was unable to determine under what circumstances the volume had been turned down.

1.7 Meteorological information

There is no aviation weather reporting at CAD4. The nearest airport to CAD4 that issues aerodrome routine meteorological reports (METARs) is Castlegar/West Kootenay Regional Airport (CYCG), BC, 15 NM north of CAD4.

The conditions recorded at 1100 indicated the following:

- winds 090° true (T) at 3 knots, varying from 340°T to 150°T
- visibility 15 statute miles
- few clouds at 100 feet above ground level (AGL), and scattered clouds at 7500 feet AGL and 11 000 feet AGL
- temperature 0 °C, dew point −1 °C
- altimeter setting 30.03 inches of mercury

The Environment and Climate Change Canada weather observation station closest to CAD4 is at Warfield, BC, 6 NM to the northwest. The conditions recorded at 1100 were a temperature of 2.2 °C and a dew point of −2.5 °C, winds 160°T at 14 km/h.

At the time of the occurrence, the sky was clear and the sun was about 18° above the horizon and directly ahead of the aircraft.[18] There was snow on the ground surrounding the runway, and the runway was wet. These conditions created glare for both flight crew members during the approach.

1.8 Aids to navigation

CAD4 has established IFR approaches for runways 16 and 34, which are published by NAV CANADA. In this occurrence, the crew conducted an approach to Runway 16 due to favourable winds and an active NOTAM,[19] which had closed the airspace south of the airport.

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18 U.S. Naval Observatory, "Astronomical Applications Department, Sun or Moon Altitude/Azimuth Table" at https://aa.usno.navy.mil/data/docs/AltAz.php (last accessed 25 June 2019).

19 According to NAV CANADA, *Aeronautical Information Management – Canadian NOTAM Procedures Manual*, Version 19.2 (31 January 2019), section 1.2, p. 11, a Notice to Airmen (NOTAM) "is a notice distributed by means of telecommunications containing information concerning the establishment, conditions or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations."

1.9 Communications

1.9.1 General

According to the *Transport Canada Aeronautical Information Manual* (TC AIM), an MF area is "established at an aerodrome if the traffic volume and mix of aircraft traffic at that aerodrome is such that there would be a safety benefit derived from implementing MF procedures."[20] CAD4 is an uncontrolled aerodrome,[21] and it has an MF area that extends from the centre of the aerodrome outward to a radius of 5 NM and up to an altitude of 4400 feet ASL or 3000 feet AGL. The TC AIM also states that "[a]ircraft operating within the area in which the MF is applicable (MF area) shall be equipped with a functioning radio capable of maintaining two-way communication."[22]

Section 602.101 of the *Canadian Aviation Regulations* (CARs)[23] stipulates the MF reporting procedures for VFR aircraft approaching an uncontrolled aerodrome. The investigation determined that the flight crew completed the required communications during the approach and landing.

Communications on the MF in use at CAD4 are not recorded.

1.9.2 Airport vehicles

Operator 1 had been using Airport 2 and a skid steer for snow removal. The skid steer was not equipped with a VHF radio; therefore, Operator 1 relied on a hand-held VHF radio for communication while using the skid steer.

TC's *Aerodromes Standards and Recommended Practices* (TP 312) sets out the communications standards for vehicles operating on the manoeuvring area[24] at an aerodrome, according to which, a vehicle

> (a) broadcasts prior to entering, exiting or changing location on the manoeuvring area, stating the vehicle position and intentions on the MF or ATF, as applicable;
>
> (b) broadcasts when on the manoeuvring area to advise pilots of vehicle positions and intentions;

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20 Transport Canada, TP 14371E, *Transport Canada Aeronautical Information Manual* (TC AIM), RAC – Rules of the Air and Air Traffic Services (11 October 2018), section 4.5.4.

21 "An uncontrolled aerodrome is an aerodrome without a control tower, or where the tower is not in operation." (Source: Ibid., section 4.5.1.)

22 Ibid., section 4.5.4.

23 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Section 602.101.

24 Section 101.01 of the *Canadian Aviation Regulations* (CARs) defines the manoeuvring area as "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."

(c) broadcasts when requested, to provide runway condition reports and the location of other known ground traffic present on the manoeuvring area; and

(d) gives way to aircraft at all times.[25]

The airport vehicle operators at CAD4 generally work alone. However, during snowfalls or other periods of significant weather, 2 or more operators may be working at the same time. At the time of the occurrence, CAD4 did not have separate procedures or policies in place outlining how multiple vehicles operating at the same time should communicate. Consequently, individual operators were required to follow the communications standards outlined in TP 312 and broadcast their intentions and position once they were on the manoeuvring area.

1.10 Aerodrome information

The City of Trail owns and operates CAD4 under a Civil Aviation Airport Certificate issued by TC on 15 February 2014, in accordance with CARs section 302.03.[26]

The airport is located 3.5 NM south of Trail, in the Columbia River valley. There is a single asphalt runway (Runway 16/34) that is 4001 feet long and 75 feet wide and at an elevation of 1427 feet ASL.

The airport serves general aviation flights, scheduled commercial flights, and rotary-wing aircraft operations throughout the year during daylight hours.

1.11 Flight recorders

1.11.1 Cockpit voice recorder

1.11.1.1 General

The occurrence aircraft was equipped with a cockpit voice recorder (CVR), as required by regulation. The CVR was capable of recording only 30 minutes before it began to overwrite previously recorded material. The Pacific Coastal Airlines Ltd. *Company Operations Manual* instructs the flight crew to pull the CVR circuit breaker in the event of a TSB-reportable incident.[27] In this case, the flight crew did not isolate the recording before it was overwritten. Therefore, the CVR was not available for review, and information that could have been valuable to the investigation was lost.

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25 Transport Canada, TP 312, *Aerodromes Standards and Recommended Practices*, 5th edition (effective 15 September 2015), paragraph 8.5.1.7, p. 300.

26 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Section 302.03.

27 Pacific Coastal Airlines Ltd., *Company Operations Manual*, Amendment 32 (15 January 2015), section 3.3.4(5): Cockpit Voice Recorder (CVR).

1.11.1.2 TSB recommendation on cockpit voice recorder duration

On 09 March 1999, the TSB issued Recommendation A99-02 as part of its investigation into an accident involving Swissair Flight 111, a McDonnell Douglas MD-11 aircraft that struck water near Peggy's Cove, Nova Scotia, after the crew diverted the flight to Halifax, Nova Scotia, because of smoke in the cockpit.[28]

One of the shortcomings identified during the investigation was the limited recording capacity of the aircraft's CVR. The CVR was able to record only 30 minutes, and therefore did not capture the timeframe when the fire started.

A lack of recorded voice and other aural information can inhibit safety investigations and delay or prevent the identification of safety deficiencies. Given the need for longer periods of recorded sound to capture the initiating events of aviation accidents, and the availability of 2-hour CVRs, the Board believed that such recorders should be mandated by regulatory authorities worldwide. However, it also recognized that a period of several years may be reasonably required for manufacturers and operators to implement this change. The Board believed that, with appropriate lead time, a retrofit program was warranted for aircraft already in service. Therefore, the Board recommended to both TC and the European Joint Aviation Authorities that:

> As of 01 January 2005, all aircraft that require both an FDR and a CVR be required to be fitted with a CVR having a recording capacity of at least two hours.
>
> **Transportation Safety Recommendation A99-02**

Since the latest reassessment of Recommendation A99-02 in March 2019, amendments to the regulations pertaining to CVRs have been published in *Canada Gazette*, Part II.[29] The new regulations require a CVR with a recording time of least 2 hours for all multi-engined turbine-powered aircraft that are configured for 6 or more passenger seats and for which 2 pilots are required by the aircraft type certificate or by the subpart under which the aircraft is operated. The new regulations will come into effect in May 2023, 4 years after their publication.

1.12 Wreckage and impact

There was no wreckage or impact.

1.13 Medical and pathological information

Not applicable.

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28 TSB Aviation Investigation Report A98H0003.

29 Government of Canada, *Canada Gazette*, Part II, Volume 153, Number 11 (10 May 2019): Regulations Amending the Canadian Aviation Regulations (Parts I and VI – Flight Data Recorder and Cockpit Voice Recorder).

1.14 Fire

Not applicable.

1.15 Survival aspects

Not applicable.

1.16 Test and research

Not applicable.

1.17 Organizational and management information

1.17.1 Pacific Coastal Airlines Ltd.

1.17.1.1 Organization

Pacific Coastal Airlines Ltd. is an air operator with operations approved under Subpart 704 (commuter operations) and Subpart 705 (airline operations) of the CARs. The company operates 20 aircraft, including 7 Beechcraft 1900Cs. Its main base of operations is at CYVR, in the South Terminal. The airline is privately owned and services communities throughout BC and Alberta.

1.17.1.2 Safety management system

As a CARs Subpart 705 air operator, Pacific Coastal Airlines Ltd. is required to implement a safety management system (SMS)[30] in accordance with section 107.02 of the CARs.[31] Pacific Coastal Airlines Ltd. first established its SMS in 2007.

1.17.2 Trail Airport

1.17.2.1 Organization

CAD4's organizational structure consists of an accountable executive, a part-time airport manager, who is also the SMS manager, a full-time airport maintenance technician, and 2 part-time airport operation specialists. The airport maintenance technician works 4 days a week, and the 2 airport operation specialists split the remaining 3 days of the week.

From February 2014 to March 2016, the airport manager position had been full-time. In April 2016, a new airport manager was appointed in a part-time role. At the time of his

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30 Section 101.01 of the *Canadian Aviation Regulations* (CARs) defines an SMS as "a documented process for managing risks that integrates operations and technical systems with the management of financial and human resources to ensure aviation safety or the safety of the public."

31 Transport Canada, SOR/96-433, *Canadian Aviation Regulations*, Section 107.02.

appointment, the new airport manager had no aviation experience or aerodrome knowledge.

TC does not approve or set out experience requirements for the airport manager position at certified airports.

1.17.2.2 Safety management system

As a certified airport, CAD4 is required to implement an SMS in accordance with CARs section 107.02.[32] CAD4 established its SMS in 2014.

1.17.2.2.1 Proactive Hazard Review

According to the CAD4 *Safety Management System Policy Manual*, "[a] review of hazards is conducted at least annually, or when major changes occur at the Airport (i.e. changes to staff, equipment, air carrier frequency, aircraft type or destination)."[33] This type of review is proactive in nature and is used to identify hazards.

Pacific Coastal Airlines Ltd. has been offering 2 scheduled flights daily from CYVR to CAD4 since April 2006. In the winter of 2018, the airline added an extra flight to CAD4 on Sundays, Mondays, and Fridays.[34] Although this constituted a change in air carrier frequency, a hazard review was not completed at CAD4 before the extra Pacific Coastal Airlines Ltd. flights were added to the schedule.

1.17.2.2.2 Previous runway incursions at CAD4

Two SMS hazard reports were generated following runway incursions at CAD4 in 2017:

- In January 2017, a private aircraft taxied onto the runway while a Pacific Coastal Airlines Ltd. flight was on approach. The Pacific Coastal Airlines Ltd. crew recognized the conflict and completed a go-around while the private aircraft cleared the runway.
- In April 2017, a runway incursion occurred involving an airport vehicle and an inbound medical evacuation flight. The airport vehicle approached the runway and stopped at the runway holding position marking. The airport vehicle operator then broadcast his intention to enter the runway on the radio and received no reply. As the airport vehicle entered the runway, the operator saw the inbound aircraft and quickly left the runway area. The aircraft landed uneventfully.

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32 Ibid.

33 City of Trail, *Safety Management System Policy Manual* (effective 19 April 2017), section 3.2: Proactive Hazard Identification, p. 24.

34 Pacific Coastal Airlines Ltd., "Pacific Coastal Airlines' 2018 Winter Schedule," available at https://www.pacificcoastal.com/pacific-coastal-airlines-2018-winter-schedule/ (last accessed 07 February 2020).

The SMS manager had completed a safety investigation and risk assessment for both events; however, in a subsequent 2017 Management Review, the events were deemed unrelated to the airport operations.[35] Therefore, airport operations were not reviewed or changed based on these 2 occurrences. In addition, the safety goals and objectives for 2018, set out in the 2017 Management Review, did not include an objective related to preventing runway incursions.

1.18 Additional information

1.18.1 Guidelines and standards regarding vehicle conspicuity

1.18.1.1 Colour

TC's *Aerodrome Standards and Recommended Practices* (TP 312) states that "[a]ll mobile objects to be marked are coloured or display flags."[36] While operating at an airport, vehicles are considered mobile objects.

The U.S. Federal Aviation Administration's Advisory Circular AC150/5210-5D provides guidelines and standards for airport vehicles based in the U.S. It notes that

> [a]irport vehicle paint and markings are a safety of flight requirement. The approved colors/markings herein assure conspicuity of vehicles operating in the AOA [air operations area] from both the ground and air.[37]

The truck involved in this occurrence was painted white, with a black front grill and black bumper (Figure 2).

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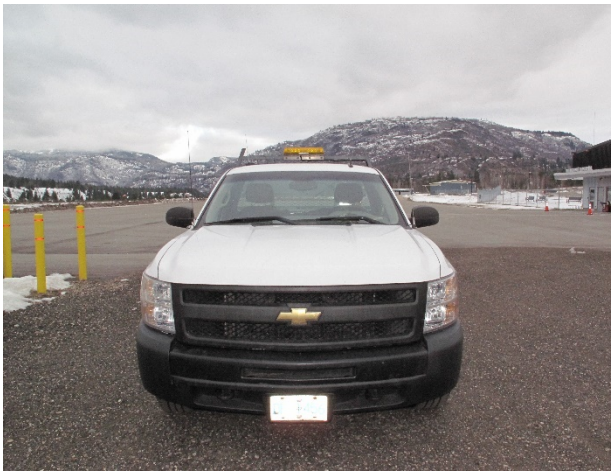
35 The review indicated that "there were 2 occurrences in which aircraft incursions were averted, and as they were unrelated to airport operations they can be dismissed." (Source: Trail Regional Airport, *Management Review – 2017*, Trends: Aircraft Related, p. 2)

36 Transport Canada, TP 312, *Aerodromes Standards and Recommended Practices*, 5th edition (effective date 15 September 2015), paragraph 6.2.2.1, p. 289.

37 Federal Aviation Administration (FAA), Advisory Circular (AC) 150/5210-5D, *Painting, Marking, and Lighting of Vehicles Used on an Airport* (01 April 2010), Section 3. Vehicle Painting, p. 2.

Figure 2. The occurrence vehicle, referred to by Trail Airport as Airport 2 (Source: TSB)



1.18.1.2 Lights

The airport vehicle was equipped with an amber beacon affixed to a rack installed above the airport vehicle cab (Figure 2). The beacon met the applicable standard for lighting of mobile objects.[38] During the occurrence, the airport vehicle was operating with the beacon on and functioning.

The AVOP Study Guide states that vehicle headlights "must be turned on while operating on airside."[39] In this occurrence, the airport vehicle's headlights were not turned on when it was being operated on the runway. However, the airport vehicle was equipped with daytime running lights, which were on and functioning at the time of the occurrence.

1.18.2 Guidance on the prevention of runway incursions

1.18.2.1 International Civil Aviation Organization

ICAO published Doc 9870 AN/463, *Manual on the Prevention of Runway Incursions*, to specifically address "the subject of runway incursion prevention as it relates to the safe operation of aircraft, air traffic management, vehicle movement on the manoeuvring area and aerodrome management."[40]

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38 Transport Canada, TP 312, *Aerodromes Standards and Recommended Practices*, 5th edition (effective date 15 September 2015), section 6.3.2 Lighting of Objects – Mobile Objects, p. 289.

39 City of Trail, *Airport Operations Manual*, Appendix F – *Airport Vehicle Operator Permit (AVOP) Study Guide* (effective date 01 April 2017), p. 13.

40 International Civil Aviation Organization, Doc 9870 AN/463, *Manual on the Prevention of Runway Incursions*, First Edition (2007), Chapter 1, section 1.3, p. 1-2.

The manual provides a systemic approach to examining contributory factors and offers recommendations to prevent runway incursions. The focus is not only on operational personnel and human limitations, but also on the operational system in its entirety. More specifically, Doc 9870 states the following:

> Active failures by operational personnel are sometimes a consequence of flaws in the system, sometimes a result of well-known and documented human limitations, but usually are a combination of the two. A true systemic approach to safety must consider latent conditions in the system as well as active failures on the front lines of operations. Such a systemic approach underlies this manual.[41]

ICAO Doc 9870 provides best practices to be used for communications by flight crews and airside vehicle drivers. It also provides tools for training and prevention programs and lists common pilot- and driver-related factors that can contribute to a runway incursion.

Common pilot-related factors that can contribute to a runway incursion include a breakdown in communications and performance of mandatory head-down tasks, which reduces situational awareness.[42] Common driver-related factors include failure to obtain clearance to enter the runway, communication errors, and inadequate training in airside vehicle operations.[43]

1.18.2.2 Transport Canada

TC has a website dedicated to runway incursions. At the time of writing this report, 6 publications, 4 *Aviation Safety Letter* articles, and 7 Advisory Circulars[44] on runway safety and related matters were available to the public.

1.18.2.3 NAV CANADA

Runway incursions are one of NAV CANADA's top 8 risks to operational safety, as identified by a risk assessment using information from a variety of sources, including frontline employees. NAV CANADA actively pursues the prevention of runway incursions, both internally and with other aviation stakeholders, through publications, information sharing, and safety forums, among other initiatives.

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41 Ibid., Foreword, p. iv.

42 Ibid., section 2.3, pp. 2–3.

43 Ibid., section 2.5, pp. 2–4.

44 Transport Canada, "Runway Incursions," at https://www.tc.gc.ca/en/services/aviation/operating-airports-aerodromes/safe-runways/runway-incursions.html (last accessed 07 February 2020).

Given the critical role of phraseology in preventing runway incursions, NAV CANADA has published 2 guidance documents[45,46] on phraseology to be used by pilots flying VFR and by ground vehicle operators.

In 2019, NAV CANADA began providing information to TC in cases where NAV CANADA had safety concerns related to a perceived student pilot proficiency deficiency (e.g., related to language). Many of these safety concerns relate to runway incursions. TC has been able to use this information to assist in its oversight of flight training schools.

In 2019, NAV CANADA developed a national NAV CANADA flight school agreement template that can be tailored to the needs of individual flight schools. This template includes the key elements that have proven to be effective practices, some of which may assist with preventing runway incursions.

NAV CANADA has published a Runway Safety webpage[47] to help airport operators establish runway safety teams at their airports.

NAV CANADA facilitates the Canadian Aviation Safety Officer Partnership (CASOP), a safety forum held twice a year, with representation from all aviation stakeholder groups.[48] The intent of the forum is to discuss safety issues, and share safety-related information within Canada's aviation community.

1.18.3 Human performance

1.18.3.1 Visual performance

The mountainous terrain surrounding CAD4 does not allow for a straight-in approach to Runway 16. The river valley in which the airport is located is narrow, and the final approach for Runway 16 is offset by 20°. Aircraft are required to join the final leg of the approach less than 1 NM from the runway threshold. In this occurrence, both pilots had lowered the aircraft's sun visors (Figure 3) to combat solar glare during the approach and subsequent landing. Yet neither pilot saw the airport vehicle on the runway until after they had landed.

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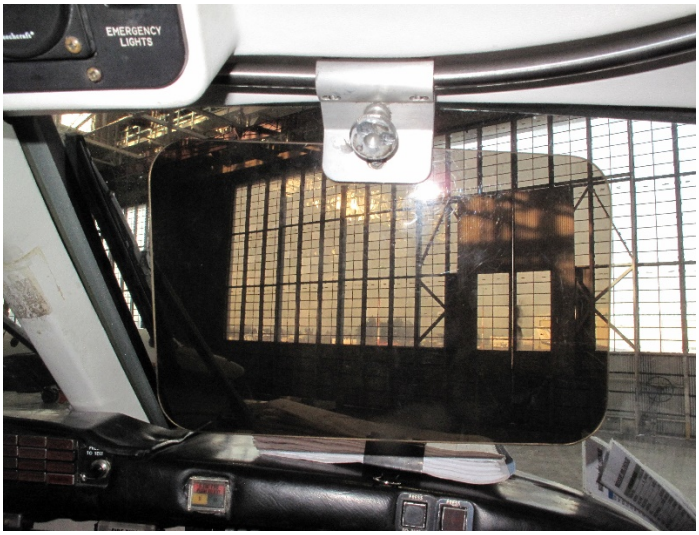
45 NAV CANADA, *VFR Phraseology*, Version 1 (April 2018), at http://www.navcanada.ca/EN/media/Publications/VFR%20Phraseology.pdf (last accessed 07 February 2020).

46 NAV CANADA, *Ground Traffic Phraseology*, Version 1 (April 2018), at http://www.navcanada.ca/EN/media/Publications/Ground%20Traffic%20Phraseology.PDF (last accessed 07 February 2020).

47 NAV CANADA, Runway Safety, at https://www.navcanada.ca/EN/products-and-services/Pages/on-board-safety-initiatives-runway-safety.aspx (las accessed 26 February 2020).

48 Canadian Aviation Safety Officer Partnership, at www.casop.ca (last accessed 26 February 2020).

Figure 3. The sun visor in the occurrence aircraft (Source: TSB)



1.18.3.2 Solar glare

Solar glare[49] from direct or reflected sunlight affects visual performance by reducing visual acuity and contrast.

Generally speaking, there are 2 types of glare: discomfort glare and disability glare. Discomfort glare can affect visual performance by distracting people and making them look away from the source of the glare. Disability glare reduces the contrast of objects with their background and can vary in intensity.

Glare is most intense when the sun is low on the horizon. The degree of solar glare depends on the sun's position and on the reflectivity of surfaces in relation to the field of view.

1.18.4 TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. The TSB publishes the Watchlist to focus the attention of industry and regulators on the problems that need to be addressed today.

The risk of collisions from runway incursions is a 2018 Watchlist issue. Since this issue was first added to the Watchlist in 2010, the TSB has completed 10 investigations[50] into runway incursions as well as a safety issues investigation focused on the south complex parallel

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49 Glare is "an intrusive light source, irrespective of whether it is viewed directly or indirectly." (Definition from D. Gradwell, D. J. Rainford, *Ernsting's Aviation and Space Medicine* 5th Edition [CRC Press, 2016], p. 275.)

50 TSB aviation investigation reports A10W0040, A11Q0170, A13H0003, A13O0045, A13O0049, A14C0112, A14H0002, A14W0046, A16O0016, and A16W0170.

runways at Toronto/Lester B. Pearson International Airport (CYYZ), Ontario.[51] In late 2018 and early 2019, the TSB initiated 3 additional investigations.[52] Although there has not been a recent accident as a result of a runway incursion in Canada, the potential consequences of such a collision could be catastrophic.

The Board is concerned that the rate of runway incursions in Canada and the associated risks of collision will remain until effective defences tailored to address previously identified hazards are implemented at airports and in aircraft, vehicles, and air traffic service facilities across Canada.

ACTIONS REQUIRED

- This issue will remain on the TSB Watchlist until the rate of runway incursions, particularly the most severe ones, demonstrates a sustained reduction.
- Transport Canada and all sectors of the aviation industry must continue to collaborate and develop tailored solutions to identified hazards at Canadian airports. These solutions could include improvements in air traffic control procedures, surveillance and warning systems, runway and taxiway designs, holding position visual aids, and flight crew training and procedures.
- Modern technical solutions, such as in-cockpit electronic situational awareness aids, and direct-to-pilot warnings, such as runway status lights, should also be implemented.

1.19 Useful or effective investigation techniques

Not applicable.

51 TSB Air Transportation Safety Issue Investigation Report A17O0038.

52 TSB air transportation safety investigations A18P0177 (this occurrence), A19O0006 (ongoing), and A19Q0015.

2.0 ANALYSIS

2.1 Introduction

The runway incursion occurred during the hours of daylight in visual meteorological conditions, when the aircraft landed while the flight crew was unaware that an airport vehicle was still on the active runway.

The investigation found no indication that the aircraft's systems, or the flight crew's performance, played a role in this occurrence.

As a result, the analysis will focus on communications from the flight crew and the airport vehicle operators, visual conditions, and the effectiveness of the airport's operations.

2.2 Communication

Mandatory frequency (MF) areas are established surrounding uncontrolled aerodromes to facilitate communication between aerodrome users. In this occurrence, the flight crew followed communication procedures, as per the *Canadian Aviation Regulations* (CARs), as they approached the airport.

Trail Airport (CAD4) had established communication procedures for ground operations. Several of these procedures were complied with on the day of the occurrence. However, although a radio functionality check was required before entering the manoeuvring area, per the *Airport Vehicle Operator Permit (AVOP) Study Guide*, the truck driver (Operator 1) did not conduct one. As a result, Operator 1 did not realize that the radio volume had been turned down to a level that prevented effective communication. Consequently, Operator 1 could not confirm that the flight crew or the other airport vehicle operator (Operator 2) had heard his broadcast stating that he was entering the active runway.

Effective communication in an MF area can prevent aerodrome users from making assumptions about the movements and intentions of others. For example, the snowplow driver (Operator 2) attempted to inform the truck driver (Operator 1) of the inbound aircraft, but this communication was not acknowledged. Operator 2 assumed that Operator 1 had heard the broadcast about the inbound aircraft's estimated time of arrival and did not make any further attempts to communicate. If users of an MF are not required to confirm that their broadcasts are heard and understood in an airport environment, there is a risk that movements will be made without the knowledge of other users, which could lead to a collision.

In this occurrence, gaps in communication protocol and missed opportunities for communication between aerodrome users contributed to Operator 1 being unaware of the inbound aircraft and vice versa. The truck driver (Operator 1) did not broadcast the vehicle position or his intentions when changing location on the runway, contrary to what is required by Transport Canada's *Aerodrome Standards and Recommended Practices* (TP 312). Broadcasting the vehicle's position and the operator's intentions would have greatly increased the chances of the flight crew becoming aware of his presence. The absence of a

broadcast reinforced the flight crew's assumption that the runway was clear, and they continued their approach to land.

This occurrence highlights that the lack of clear communication and coordination can introduce hazards when operating on or around active runways. Effective communication and coordination help ensure that all aerodrome users have a shared awareness of the current situation: flight crews are aware of vehicles operating in the vicinity of active runways, and airport operators are aware of aircraft departures and arrivals. As observed in this occurrence, if airport vehicle operators do not follow communication procedures, there is increased risk of a runway incursion due to inaccurate awareness of other aerodrome users.

2.3 Visual conditions

In this occurrence, the visual conditions made it more difficult for the flight crew to detect the airport vehicle on the active runway.

During the aircraft's approach, the sun, low on the horizon, reflected off the wet runway, creating a solar glare condition that diminished the flight crew's ability to detect the airport vehicle on the runway. Specifically, the glare made it difficult for the flight crew to see the entire length of the runway.

The paint colour and markings on airport vehicles help flight crews see them. The occurrence airport vehicle was painted white and had black accents, and the ground surrounding the runway was snow-covered. The airport vehicle's flashing beacon and daytime running lights were on. However, under the prevailing visual conditions, the markings and colour were insufficient to make the vehicle conspicuous to the flight crew. It is unknown whether the flight crew would have been able to see the airport vehicle on the runway if it had had its full headlights on.

If airport vehicles are not conspicuous, they may not be seen by flight crew, increasing the risk of potential collisions.

2.4 Airport operations

2.4.1 Training

The regulations and standards governing airport operations in Canada are general in nature. This places the onus on airports to develop a training program that ensures its airport vehicle operators are adequately prepared to perform the tasks they are assigned.

In this case, although CAD4 had established a training program for airport vehicle operators, the program did not provide guidance for operations with multiple vehicles on the manoeuvring area. In this occurrence, the 2 airport vehicle operators were unaware of each other's location and intentions during the landing of the aircraft. If training programs for airport vehicle operators do not address common operational scenarios, there is

increased risk that airport vehicle operators will lack the knowledge needed to safely conduct their duties.

As well, at the time of the occurrence, Operator 1 and Operator 2 had not completed all the requirements specified in the *Airport Staff Training Manual*. For example, training related to operating a vehicle on the critical portion of the runway had not been completed. When airport operators' training plans are not fully implemented, there is increased risk that airport vehicle operators will miss important actions, compromising safety.

2.4.2 Safety management systems

An airport's safety management system (SMS) must be able to proactively identify hazards and effectively manage the safety risks within the airport's operation. Runway incursions create the potential for collision; therefore, corrective action taken following occurrences must address this risk.

There were 2 runway incursions at CAD4 in 2017. The SMS manager had completed a safety investigation and risk assessment for both events; the events were deemed unrelated to the airport operations and procedures were not reviewed or revised. The airport's SMS goals and objectives for 2018 did not include an objective related to mitigating runway incursions.

If proactive hazard identification and mitigation strategies are not implemented under an airport's SMS, the risk of incursions and collisions will remain.

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. Although a radio functionality check was required before entering the manoeuvring area, per the *Airport Vehicle Operator Permit (AVOP) Study Guide*, the truck driver (Operator 1) did not conduct one. As a result, Operator 1 did not realize that the radio volume had been turned down to a level that prevented effective communication.

2. The truck driver (Operator 1) did not broadcast the vehicle position or his intentions when changing location on the runway, contrary to what is required by Transport Canada's *Aerodrome Standards and Recommended Practices* (TP 312). Broadcasting the vehicle's position and the operator's intentions would have greatly increased the chances of the flight crew becoming aware of his presence.

3. The sun, low on the horizon, reflected off the wet runway, creating a solar glare condition that diminished the flight crew's ability to detect the airport vehicle on the runway.

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 users of an MF are not required to confirm that their broadcasts are heard and understood in an airport environment, there is a risk that movements will be made without the knowledge of other users, which could lead to a collision.

2. If airport vehicle operators do not follow communication procedures, there is increased risk of a runway incursion due to inaccurate awareness of other aerodrome users.

3. If airport vehicles are not conspicuous, they may not be seen by flight crew, increasing the risk of potential collisions.

4. If training programs for airport vehicle operators do not address common operational scenarios, there is increased risk that airport vehicle operators will lack the knowledge needed to safely conduct their duties.

5. When airport operators' training plans are not fully implemented, there is an increased risk that airport vehicle operators will take inappropriate actions or miss important actions, compromising safety.

6. If proactive hazard identification and mitigation strategies are not implemented under an airport's safety management system, the risk of incursions and collisions will remain.

3.3 Other findings

These items could enhance safety, resolve an issue of controversy, or provide a data point for future safety studies.

1. The flight crew did not isolate the cockpit voice recorder's recording before it was overwritten. Therefore, the cockpit voice recorder was not available for review, and information that could have been valuable to the investigation was lost.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 Pacific Coastal Airlines Ltd.

After this occurrence, internal safety management system (SMS) hazard reports were filed as required. An internal investigation was initiated to develop hazard mitigation.

4.1.2 Trail Airport

Since the occurrence, the Trail Airport (CAD4) has reported to have implemented the following safety actions:

- It developed site-specific, clear, workable very high frequency (VHF) radio check and operating procedures.
- It reviewed and amended Airport Vehicle Operator Permit (AVOP) procedures to include procedures for entering and exiting the runway.
- It developed procedures for airside operations to assist vehicle operators if they find themselves on a runway occupied by an aircraft.
- It identified communication protocols to improve safety at the airport (radio procedures among airport staff on duty and between shifts, as well as staff-to-supervisor and airport-to-airline communications). It made changes to procedures, where appropriate.
- It amended the Apron Management Plan.
- All employees reviewed the airport's procedure for communicating a near-miss incident.
- The *Airport Staff Training Manual* was reviewed, and improvements were made.
- Employees were retrained and retested for AVOP and radio procedures. Individual learning plans were developed for employees to become confident operating a VHF aeronautical radio.
- Ground and aviation radios were mounted in the skid steer and Snowplow 2 to increase situational awareness. Ground radio speakers have now been installed in all airport equipment.
- All employees met to discuss informal radio operating procedures, including what to do if the other operator does not respond to a radio communication and shared responsibility for safety and communication.
- Procedures in the winter operations manual were revised with respect to staffing levels and airside snow clearing when a commercial air carrier is en route.
- The airport provided feedback to the airline requesting radio communication when the aircraft is on final approach (15 to 20 minutes) and on short final approach.
- The airport identified all duties superfluous to core responsibilities and determined how these tasks can be managed without affecting day-to-day operations. The

airport manager published guidelines concerning these tasks in the *Airport Staff Training Manual* and trained staff in these guidelines.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 05 February 2020. It was officially released on 05 March 2020.