Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A14W0046

RUNWAY INCURSION

AIR GEORGIAN LIMITED
BEECH 1900D, C-GWGA
CALGARY INTERNATIONAL AIRPORT, ALBERTA
29 MARCH 2014

Canada

Aviation Investigation Report A14W0046

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Summary

On 29 March 2014, the Air Georgian Limited Beech 1900D (registration C-GWGA, serial number UE-309) was being taxied by company maintenance personnel to the holding bay of Runway 29 at the Calgary International Airport, Alberta, during the hours of darkness. The tower controller issued initial taxi instructions to depart Apron V, proceed via Taxiway N and Runway 26 to hold short of Taxiway Y. At 0024 Mountain Daylight Time, a runway incursion occurred when C-GWGA entered the active runway (Runway 17R) at the threshold of Runway 35L. A departing Boeing 737-700 was already airborne when C-GWGA entered the runway.

Le présent rapport est également disponible en français.

Factual information

Sequence of events

On 29 March 2014, an Air Georgian Limited aircraft maintenance engineer (AME) was required to conduct a maintenance ground run following work on the engine of a Beech 1900D aircraft (C-GWGA). At approximately 0000,[1] the AME requested permission to conduct a ground run from the Calgary Airport Authority (CAA) airport duty manager, as is required by local policy.[2] The AME was given permission to conduct the ground run at the holding bay of Runway 29 within the next 30 minutes. This was the first time the AME had been directed to this location for a ground run. The AME and an apprentice completed preparations for the ground run, reviewed the Jeppesen airport diagram, and started the aircraft.

At 0020:39, the AME contacted the NAV CANADA Calgary International Airport (CYYC) tower controller on the ground frequency with a request to taxi to the holding bay of Runway 29. The controller was expecting the call, as the airport duty manager had advised the tower of the approved request. The controller cleared C-GWGA to taxi on Taxiway N and Runway 26 to hold short of Taxiway Y (Appendix A). The clearance was acknowledged and read back correctly. The AME did not turn on the transponder, and no transponder code was assigned by the controller.

Approximately 1 minute later, C-GWGA departed from its position in front of the Air Georgian Limited hangar on Apron V. The controller was providing air traffic services to arriving and departing aircraft when C-GWGA began to taxi. It was the controller's experience that maintenance personnel did not initiate taxiing as quickly as operational flight crews after receipt of instructions. Therefore, the controller did not expect C-GWGA to start taxiing so soon after being cleared.

C-GWGA exited Apron V at the north end and turned left on Taxiway M heading west. It then continued on Taxiway M to Taxiway Y, and then turned left heading south for Taxiway C. At 0022:12, the crew of a Boeing 737-700 (B737) called the tower controller for take-off clearance on Runway 17R. The controller visually scanned the runway from south to north and then confirmed the scan by looking at the airport surface detection equipment (ASDE) display from north to south (Appendix B). The controller noticed a primary target on Taxiway Y near the intersection with Taxiway M, but concluded it was a vehicle heading for the access road that passes south of the threshold of Runway 35L. At 0022:22, the controller cleared the B737 for takeoff on Runway 17R.

C-GWGA continued to taxi on Taxiway C, and at 0024:10, crossed the hold line at the threshold of Runway 35L as the B737 crossed overhead climbing through 500 feet above ground level (agl). C-GWGA continued on to Runway 35L, and at 0024:49, called on ground

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1 All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

2 NAV CANADA, *Calgary Control Tower Unit Operations Manual,* Appendix B5, October 2013.

frequency informing the controller that C-GWGA was on Runway 35L. The controller visually confirmed the aircraft was on the runway and immediately gave instructions to turn the aircraft around to clear the runway and to proceed on Taxiway C to hold short of Runway 26. C-GWGA was then taxied to the holding bay of Runway 29, the ground run was completed, and the aircraft returned to Apron V without further incident.

Weather

The weather, as described by the 0000 aviation routine weather report (METAR) was as follows: wind 190° true at 6 knots, visibility 5 statute miles in mist, ceiling 700 feet agl overcast, temperature -6°C and dew point -7°C.

Air Georgian Limited

General

Air Georgian Limited, a subsidiary of Georgian International, was formed in 1984. The company operates Beechcraft 1900,[3] Cessna 680, and Bombardier CL600-2B19 (CRJ200) series aircraft. The company provides scheduled passenger and executive charter flights as well as aircraft maintenance, management, and training services to major airlines, corporations and individuals. The head office is located in Toronto, Ontario.

Air Georgian Limited is a Transport Canada approved maintenance organization (AMO) with a main maintenance base in Toronto, Ontario (CYYZ), and sub-bases in Calgary, Alberta (CYYC), and Kingston, Ontario (CYGK). The company has approximately 200 employees, which include pilots, maintenance personnel, office staff and management.[4] They are located at the various bases.

Safety management systems

At the time of the occurrence, the AMO had an approved safety management system (SMS). The operator's SMS Manual sets out how it will comply with Transport Canada's requirement for an SMS.

An internal company quality assurance (QA) audit conducted on 18 December 2013 found 62 individuals who had no current SMS training. A TSB review of the training files of 6 AMEs at the Calgary base found that 5 of them did not have SMS training provided by Air Georgian Limited at the time of the occurrence. Air Georgian Limited SMS Manual Section 8.3(a) states: "All other employees that have not undergone the training shall undergo a training program within the first 30 (thirty) days of employment. Whenever possible, this training should be completed as part of the initial hiring process."

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3 Air Georgian Limited operates the B1900D under *Canadian Aviation Regulations* (CARs) Sub-part 704.

4 Air Georgian Limited, *Air Georgian Limited Maintenance Policy Manual*, Part 0, Page 7.

Aircraft maintenance training program and records

The Air Georgian Limited aircraft maintenance training program is documented in the company Maintenance Policy Manual, in accordance with the applicable regulations.[5] These regulations are general in nature requiring companies to develop their own training program to ensure that maintenance personnel are adequately trained to carry out their assigned tasks. Other than human factors training, the regulations and applicable standards do not detail training syllabus requirements. The training program includes initial, recurrent and update training programs that also include human factors and regulatory training elements. The Maintenance Policy Manual states that the syllabus of each training program includes the programmed time allotted and the subject matter to be covered. The investigation could not find any examples of a training syllabus in the company manuals.

The training files of the 6 AMEs at the Calgary base contained inconsistencies in both format and data content. There was no standard format provided for the training records. Only 2 AME files contained an Air Georgian Limited computer-generated training status report. Both training status reports had numerous fields with missing data and overdue training courses. The company's December 2013 QA audit found numerous examples of employees not having current training on human factors, the Maintenance Policy Manual, the SMS, and the *Canadian Aviation Regulations* (CARs). Of the 6 training files reviewed, the majority still did not have this training documented at the time of the occurrence.

Aircraft maintenance engineer

The occurrence AME was certified and licensed in accordance with existing regulations. The AME had been licensed since February 2011. Eleven months of his experience was with Air Georgian Limited holding the position of crew chief. The AME was on a 12-hour shift schedule, starting at 1830 and finishing at 0630. The shift was 7 days on, followed by 7 days off. The AME was on the 4th day of the 7-day cycle. Fatigue was not considered a factor at the time of the occurrence.

Records indicate that the AME maintained an Aircraft Certification Authority (ACA),[6] for the following series of aircraft: C208, BE90 (King Air 200), BE02 (Beech 1900C / D) and DASH 8 100 / 200 / 300. The ACA documented that ground run and taxi authority had been granted for the Beech 1900 following training completed on 07 and 08 May 2013. The training is recorded on the Engine Run / Taxi Checklist and Authorization form. The form and the operator's Maintenance Policy Manual do not detail the exercises required or performed relating to engine run and taxi training. Air Georgian Limited does have a simulator program on taxiing designed for AMEs. This program is not required for the initial authorization to taxi aircraft but is expected to be completed within a year. The AME had not yet received or been scheduled for this component of the training after having been

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5 *Canadian Aviation Regulations*, CAR 573.06 - Training Program.

6 Qualifications for who may sign a maintenance release – *Canadian Aviation Regulations*, Part 5 - Standard 573.05.

authorized to taxi aircraft for almost 11 months. The training given to the AME consisted of only basic procedures to start and manoeuvre the aircraft.

A review of the occurrence AME's training files indicated that the AME had not received any initial or recurrent training from Air Georgian Limited in relation to company policy, procedures, technical, regulatory and human factors issues related to any work for which he was responsible.

Regulatory oversight

Since 2011, Transport Canada (TC) has conducted 2 program validation inspections (PVI) on Air Georgian Limited. The first was carried out from 28 February to 04 March 2011. One of the findings from this PVI related to the company's QA program is that it did not adequately audit the training requirements of maintenance personnel. The company's corrective action plan (CAP) was accepted, follow-up was completed, and TC closed the PVI on 11 July 2011.

The second PVI was carried out from 04 to 14 February 2014. This PVI also generated some findings related to the company's QA program. The QA program did not meet required time lines for CAPs; it did not adequately audit the appropriate use of applied tolerances for scheduled maintenance; and it did not adequately audit the qualifications of maintenance personnel applying these tolerances.

Calgary International Airport

CYYC possesses an airport certificate issued by TC. The airport consists of 3 runways, numerous taxiways and 8 aprons. In 2013, the airport was the third busiest in Canada, with 244 913 aircraft movements[7] and approximately 14.3 million passengers.[8] The airport is a complex environment due to multiple intersecting runways. The other major airports in Canada that have similar traffic movements (Vancouver, Toronto and Montréal) benefit from parallel runway layouts.

CYYC is unique among these similar airports when it comes to the handling of vehicles on the manoeuvring areas of the airport. Manoeuvring areas are those parts of an aerodrome intended to be used for the takeoff and landing of an aircraft, and for the movement of aircraft associated with takeoff and landing, excluding aprons. Vehicles approved to operate on the manoeuvring areas of CYYC do not have to obtain a clearance from air traffic services (ATS) unless the vehicle needs to cross a runway or the airport is operating under reduced / low visibility operations (RVOP / LVOP). RVOP refers to operations in visibility from below runway visual range (RVR) 2600 feet to 1200 feet, and LVOP refers to operations below RVR 1200.[9] It is more common for airports to have ATS exercise direct control over

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7 Aircraft Movement Statistics - NAV CANADA Towers and Flight Service Stations - Annual Report (TP 577) – 2013.

8 Taken from Calgary Airport Authority passenger statistics; accurate as of 11 September 2014.

9 NAV CANADA, *Canada Air Pilot*, General, Operating Minima, effective 06 February 2014.

vehicles on the manoeuvring area. The CAA has strict control on these approvals and grants them by following procedures detailed in Airside Traffic Directives.[10] To reduce vehicle traffic on the manoeuvring area, airports can provide dedicated service roads for vehicles. CYYC has limited infrastructure dedicated to vehicle operations.

All illuminated signs for the intended and actual taxi routes were functional at the time of the occurrence (Appendix C).

A review of TC Civil Aviation Daily Occurrence Reports (CADORS) was conducted as part of the investigation. The review looked at CYYC and 5 other similar Canadian airports[11] over the last 10 years. Of these 6 airports, CYYC had the lowest number of reported incidents involving vehicles on the manoeuvring areas.

Airport runway safety team

The CYYC Runway Safety Team was established in December 2011. Its goal is to promote discussion between NAV CANADA, the CAA and the users of CYYC regarding particular hazards presented by the airport environment. The Runway Safety Team is co-chaired by the NAV CANADA tower manager and the CAA director, Airfield Compliance. Meetings are scheduled twice annually, and operators who regularly use CYYC are invited to participate.

The team has the following objectives:

- improve runway safety data collection, analysis and dissemination;
- provide recommendations for improvements that reduce the risk of runway incursions at the Calgary International Airport; and
- promote discussion of runway safety issues within all user groups at the Calgary International Airport.

NAV CANADA

Control tower operations

At CYYC, air traffic services (ATS) are provided 24 hours a day by NAV CANADA. The control tower provides ATS within the control zone.[12]

During the midnight shift (2315-0745), the tower normally has a complement of 2 controllers.[13] These 2 controllers cover the 5 tower positions (airport, north ground, south ground, clearance delivery and tower co-ordination). This staffing level normally allows for 1 of the controllers to have a brief break without impacting the operation. The 2 controllers

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10 Calgary Airport Authority, *Airside Traffic Directives*, September 2013.

11 Vancouver (CYVR), Toronto (CYYZ), Montréal (CYUL), Ottawa (CYOW), Winnipeg (CYWG)

12 *Canada Flight Supplement*, Aerodrome / Facility Directory

13 NAV CANADA, *Calgary Tower Unit Operations Manual*, Appendix E8, October 2013.

assess the traffic situation and then decide between themselves when to take breaks. One of the controllers went on a break at 2345, which left the occurrence controller alone in the tower to cover all positions for the 39 minutes preceding the occurrence. The traffic was assessed as low volume and medium complexity.

Tower controller

The tower controller was certified and licensed in accordance with the regulations at the time of the occurrence. The controller had 5.5 years of controlling experience of which 2 were in the Calgary Tower. Table 1 summarizes the controller's work schedule for the 3 weeks leading up to the occurrence. The day of the occurrence was the last shift in a stretch of 6 days. The last 3 days consisted of retrograde shifts that started earlier each day. On the day of the occurrence, the controller finished a day shift at 1413 and was back to work that same evening at 2315 to start a night shift at 2345. Although the TSB has previously found that there is a risk of fatigue during night shifts associated with this type of shift rotation,[14] fatigue was not considered a factor in this occurrence.

Table 1. Controller's schedule for March 2014

Sun	Mon	Tues	Wed	Thurs	Fri	Sat
					7 Off	8 Off
9 Off	10 Off	11 Off	12 Off	13 Off	14 Off	15 Off
16 Off	17 0700- 1530	18 0700- 1530	19 0700- 1530	20 Off	21 2315-	22 -0745 Then Off
23 Off	24 1515- 2345	25 1330- 2200	26 1330- 2200	27 0700- 1530	28 0545- 1415 & 2315-	29 -0745 Then Off

Airport surface detection equipment

CYYC is equipped with an ASDE (airport surface movement radar) that provides a real-time display in the tower of aircraft and other vehicle traffic operating on airport manoeuvring areas. The type of ASDE at CYYC, the NOVA 9000, is designed to run continually and requires minimal intervention from control staff. The NAV CANADA *Manual of Operations* (MANOPS)[15] considers visual scanning as the primary technique to confirm airport traffic before issuing clearances and instructions. Controllers are advised that they

14 TSB Aviation Investigation Report A13O0049

15 NAV CANADA, *Manual of Operations* (MANOPS), Sub-part 308.

may use ASDE to supplement visual observation of airport traffic at night, when visibility is restricted, or when an operational advantage can be gained.[16]

To enhance safety during poor visibility, the ASDE is configured with virtual stop bars which are located in the vicinity of the physical hold lines; these stop bars are only depicted on the ASDE display. Air crews and vehicle operators have no indication that ATS is using this feature. Virtual stop bars reduce the potential for runway incursions by sounding an alarm when a target enters (or crosses) a runway without the stop bar being disabled first. The tower controller is responsible for disabling stop bars for all aircraft or vehicles entering (or crossing) an active runway. Aircraft that have landed (or are on the runway) and exit will not trigger an alarm. To reduce the number of false alarms, the virtual stop bars are located just beyond the hold lines. The controller has four options when selecting a virtual stop bar group: RVOP 17R, RVOP 35L, RVOP 29, and RVOP DEP 11. This only activates the virtual stop bars relevant to the selected runway.

The use of virtual stop bars is mandatory during RVOP, and may be used at other times to enhance safety. None of the virtual stop bars were active at the time of the occurrence.

Multilateration system

CYYC is one of 3 airports[17] in Canada to have installed a multilateration (MLAT) system for surface surveillance. MLAT uses a network of ground sensors to receive signals from transponders. It provides an extra layer of ground surveillance. It calculates a vehicle or aircraft position by interrogating its transponder from multiple antennas. Full airfield coverage is accomplished by using this network of sensors. The MLAT information is fused with the surface movement radar data to present the controller a picture on the ASDE display.

According to the *Calgary Tower Unit Operations Manual*,[18] all aircraft are expected to keep their transponders on when manoeuvring on aprons, taxiways and runways. Aircraft that have not previously received a transponder code from ATS are instructed to use transponder code 1000 in order to permit the civil registration to be displayed on ASDE if the aircraft is equipped with a mode S transponder.

Direction on transponder usage is found in the NAV CANADA *Canada Flight Supplement*[19] and *Canada Air Pilot*.[20] In the Jeppesen publications, direction on transponder usage is only noted in the Airport Information section for CYYC. The AME was not aware of the requirement for transponder usage while taxiing. The controller did not assign a discrete

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16 NAV CANADA, *Manual of Operations* (MANOPS), Sub-part 307.

17 Vancouver (CYVR), Toronto (CYYZ), Montréal (CYUL)

18 NAV CANADA, *Calgary Tower Unit Operations Manual,* Appendix D9, October 2013.

19 NAV CANADA, *Canada Flight Supplement*, Aerodrome / Facility Directory, Calgary International, Procedures

20 NAV CANADA, *Canada Air Pilot*, Aerodrome Chart, Taxi Chart and Parking Areas Chart for CYYC

code or instruct the AME to use transponder code 1000. It was the controller's experience that aircraft taxiied by maintenance personnel were not assigned transponder codes as consistently as aircraft on departing flights.

TSB Watchlist

The TSB Watchlist makes public a list of those issues posing the greatest risk to Canada's transportation system.

The risk of collisions on runways has been on the Watchlist since 2010. The Board remains concerned that until better defences are implemented, such as improved procedures and enhanced collision warning systems, this risk will continue.

Analysis

General

The visibility at the time of the occurrence was 5 statute miles in mist. The incursion happened during the hours of darkness, but the illuminated signs for the intended and actual taxi routes were functional at the time of the occurrence. The aircraft maintenance engineer (AME) was certified and licensed in accordance with existing regulations. The tower controller was certified and licensed in accordance with the regulations at the time of the occurrence. The analysis will focus on why the AME did not follow the intended taxi route, why this was not observed by the controller, and why the aircraft entered an active runway without authorization.

Aircraft maintenance engineer training

The taxi training given to the AME consisted of only basic procedures to start and manoeuvre the aircraft. The AME had not received training related to taxiing on the manoeuvring area. Consequently, the AME did not follow the intended taxi route even though he encountered numerous taxiway signs, airport lighting and landmarks that indicated the aircraft was not where it should have been. The fact that the AME was not aware of the requirement to activate the transponder for taxiing also points to a lack of training. The company training received by the AME was inadequate to prepare him for the complex nature of taxiing an aircraft around a large airport at night, and resulted in a runway incursion.

Aircraft maintenance training program and records

The regulations and standards for maintenance training are general in nature. This places a greater onus on the company to develop a program that ensures its employees are adequately trained for the tasks assigned. The quality assurance (QA) program required by regulations is in place to enable a company to identify issues with programs, such as training records, and strive for continuous improvement.

The training records of the Air Georgian Limited maintenance personnel were inconsistent and incomplete. The operator’s QA program did not identify many of these issues, and those that were identified were not addressed in an effective manner. This allowed tasks to be conducted by individuals that may not have been qualified to do so.

If a company does not have a system to effectively control and record training requirements, there is a risk that employees may be assigned to perform tasks for which they are not trained.

Multilateration usage at the Calgary International Airport

The occurrence controller had grown accustomed to aircraft operated by maintenance personnel not proceeding as promptly following receipt of taxi instructions as aircraft under normal operations. This led to the controller not monitoring the area where C-GWGA was operating as he had to deal with other traffic. The controller had not assigned a discrete code or instructed the AME to use transponder code 1000. Without a transponder tag, it was more difficult for the controller to notice that the aircraft was taxiing in the wrong direction. When the controller scanned the ASDE (airport surface detection equipment) display, he saw the primary target that C-GWGA produced as it approached Runway 35L, but as it was not tagged, he disregarded it as it appeared to be a vehicle. C-GWGA had not been assigned a transponder code as prescribed in the *Calgary Tower Unit Operations Manual*. This resulted in the controller not having a clear picture of where the aircraft was taxiing and, therefore, being unable to intervene prior to the aircraft crossing the hold line.

Airside vehicle operations at the Calgary International Airport

Prior to issuing a take-off clearance to the B737, the controller conducted a scan of the ASDE display to confirm the runway was clear. When he saw a primary target heading south from the intersection of Taxiway Y and Taxiway C, he made the assumption that it was a vehicle. This determination was based on the controller's experience observing vehicles behaving similarly in the past. This assumption was further reinforced by the fact that controllers are used to seeing uncorrelated ASDE targets on the taxiways in CYYC generated by vehicles that are not in contact with air traffic services (ATS). CYYC has a low number of vehicle incursions despite the fact that not all vehicle traffic is controlled by ATS. Consequently, controllers may assume an uncorrelated target is most likely a vehicle.

Except for reduced / low visibility operations, the Calgary Airport Authority does not require positive control over vehicles operating on a taxiway. This resulted in the controller making an incorrect assumption that C-GWGA was a vehicle.

Airport surface detection equipment and virtual stop bars

The ASDE installed at CYYC worked as designed. At the time of the occurrence, the controller's primary method of scanning was visual, which was appropriate given the weather and visibility. The controller used the ASDE as a tool to improve visual observation of traffic on the manoeuvring areas. The virtual stop bar feature was available but it was not used as it was not required given the visibility. With the controller working alone, during the hours of darkness and with visibility of 5 statute miles in mist, this extra tool could have been useful. If the virtual stop bar feature on ASDE is not enabled, there is an increased risk that the controller will not be alerted to an unauthorized movement across the runway hold line.

Findings

Findings as to causes and contributing factors

1. The company training received by the aircraft maintenance engineer (AME) was inadequate to prepare him for the complex nature of taxiing an aircraft around a large airport at night, and resulted in a runway incursion.

2. C-GWGA was not assigned a transponder code as prescribed in the *Calgary Tower Unit Operations Manual*. This resulted in the controller not having a clear picture of where the aircraft was taxiing and, therefore, being unable to intervene prior to the aircraft crossing the hold line.

3. Except for reduced / low visibility operations, the Calgary Airport Authority does not require positive control over vehicles operating on a taxiway. This resulted in the controller making an incorrect assumption that C-GWGA was a vehicle.

Findings as to risk

1. If the virtual stop bar feature on ASDE (airport surface detection equipment) is not enabled, there is an increased risk that the controller will not be alerted to an unauthorized movement across the runway hold line.

2. If a company does not have a system to effectively control and record training requirements, there is a risk that employees may be assigned to perform tasks for which they are not trained.

Safety action

Safety action taken

Calgary Airport Authority

On 14 April 2014, the Calgary Airport Authority (CAA) issued a letter to all operators at the Calgary International Airport (CYYC) detailing changes to the Airside Traffic Directives. The letter stated, in part, that the following changes would be effective immediately:

> The Calgary Airport Authority will no longer recognize an Aircraft Maintenance Engineer's (AME) licence as sufficient authorization to tow or taxi an aircraft on the YYC airfield… All AMEs who tow or taxi aircraft … must have an AVOP licence.

The CAA controls the training and issuance of the AVOP (airside vehicle operator's permit) licences through its Airside Traffic Directives.

In addition, the CAA has decided to equip all of its airside vehicles with transponders so they can be identified on the multilateration (MLAT) system with discrete codes. On 01 January 2015, a CAA directive came into force which requires all vehicles operating on the manoeuvring area to be equipped with an MLAT-compliant unique transponder.

Air Georgian Limited

The company conducted an internal safety management system (SMS) investigation into the occurrence and produced an initial SMS report. The company investigation identified root causes and recommended short- and long-term corrective actions.

As a result of this internal investigation by Air Georgian Limited, the company developed new policies and procedures along with a training program to support maintenance activities related to the taxiing of aircraft. These changes are detailed in a revision to the company's *Maintenance Procedures Manual* titled "Maintenance Taxi Procedures". This revision, dated 30 December 2014, incorporates the following changes:

- Policy which defines what qualifications are required to taxi aircraft;
- Direction on the duties and responsibilities of maintenance personnel involved in taxi operations, along with required equipment and charts;
- Establishment of minimum weather, runway and taxiway conditions for taxi operations;
- Creation of checklists and standard operating procedures for maintenance personnel involved in the ground manoeuvring of aircraft; and
- An initial and recurrent training program that includes both classroom and simulator sections.

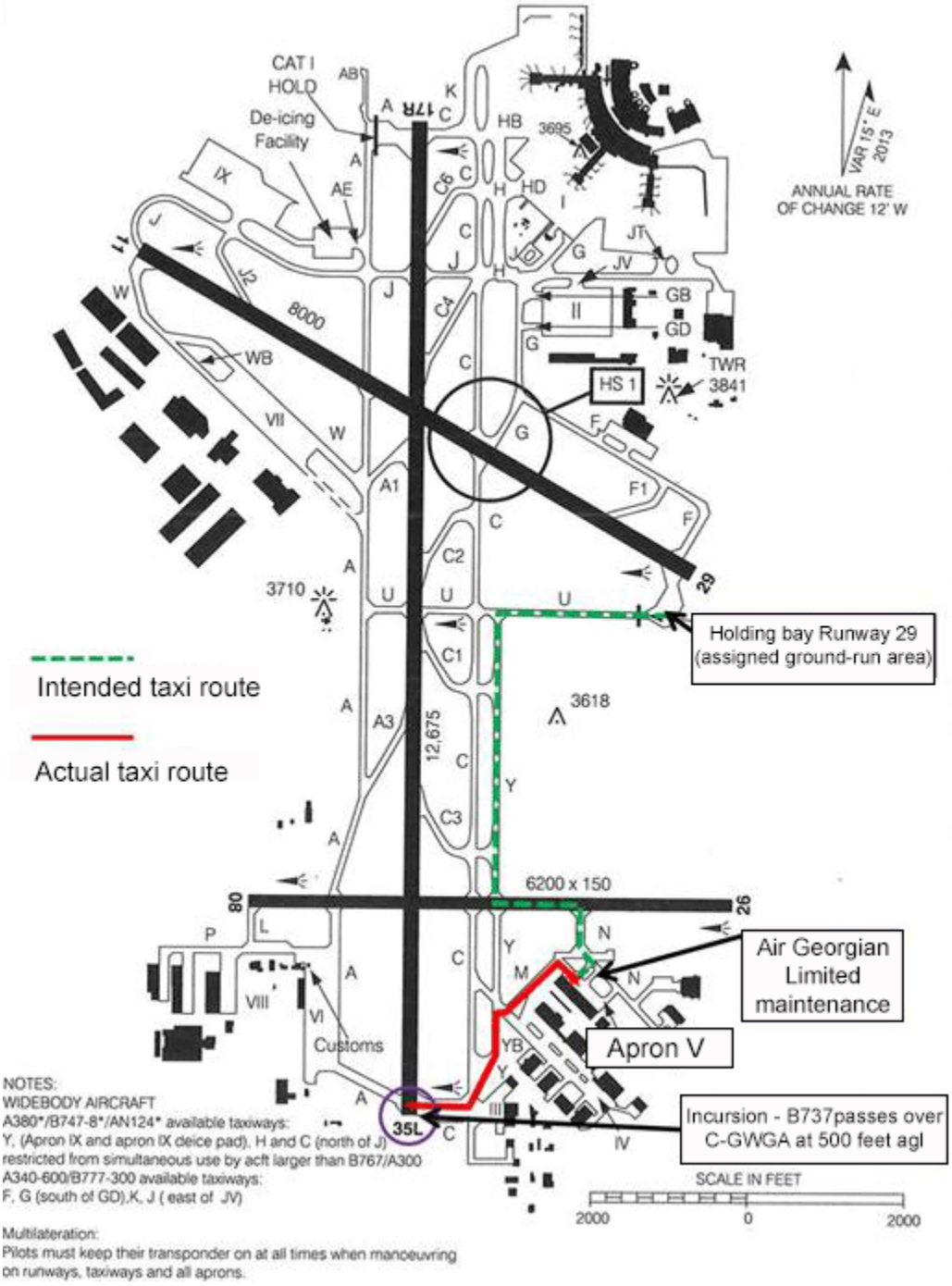
As of January 2015, approximately 70% of the company's maintenance personnel had completed the training. Personnel have been restricted from taxiing aircraft until they have completed training.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 22 April 2015. It was officially released on 28 April 2015.

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

Appendices

Appendix A – Calgary International Airport diagram and taxi routes



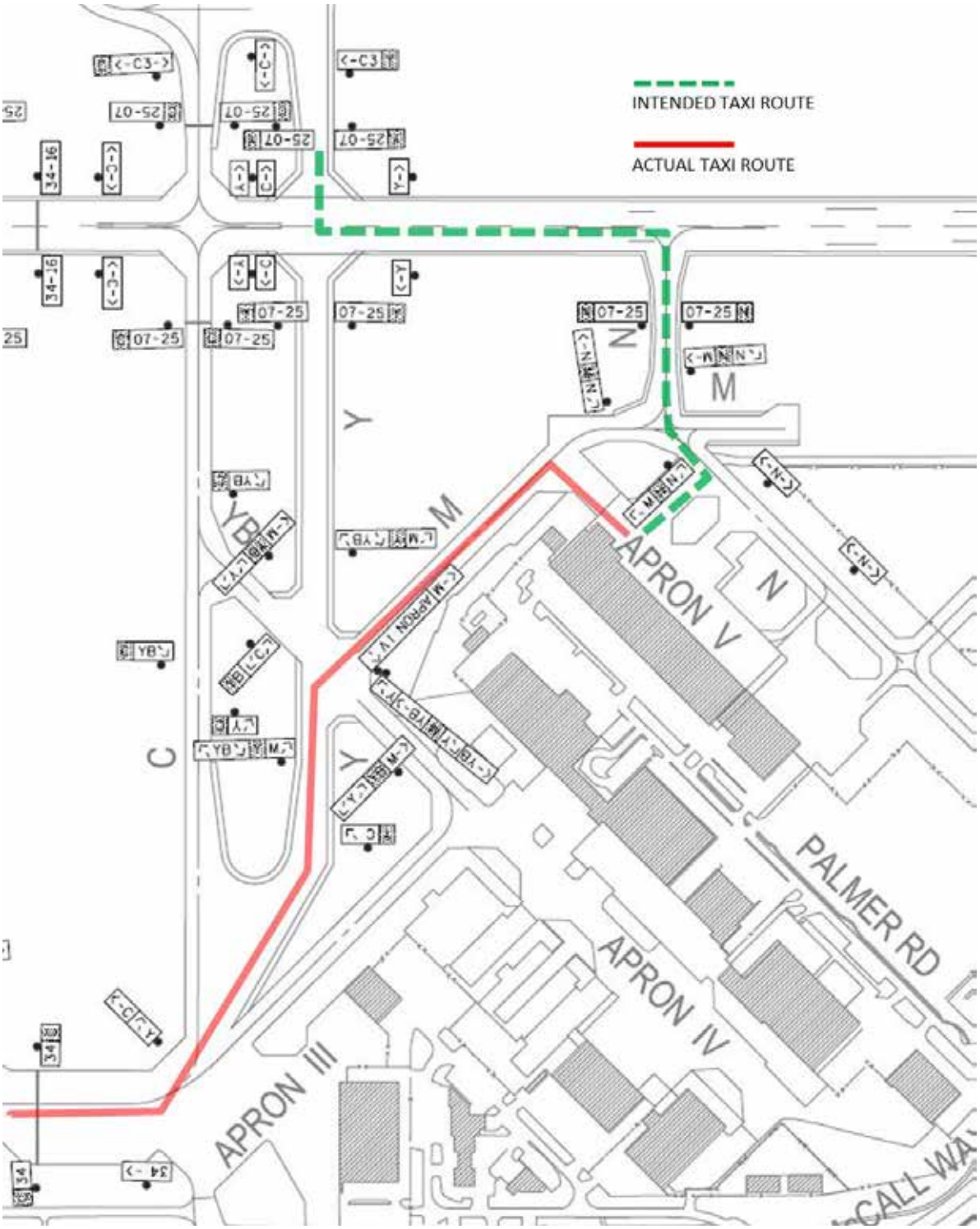
Not for navigational use

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

Appendix B – Airport surface detection equipment (ASDE) display at 0022 when Boeing 737 was cleared for takeoff

Source: NAV CANADA, Tower ASDE display, with TSB annotations

Appendix C – Illuminated Airport Signage - Southside



Not for navigational use

Source: Calgary Airport Authority, with TSB annotations