



Transportation
Safety Board
of Canada

Bureau de la sécurité
des transports
du Canada

AVIATION INVESTIGATION REPORT A16O0149



Risk of collision

Porter Airlines Inc., DHC-8-402, C-GKQA
and

Jazz Aviation LP (dba Air Canada Express),
DHC-8-402, C-GXJZ

Sudbury Airport, Ontario, 9.5 nm SW

14 October 2016

Canada 

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The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

On 14 October 2016, a Porter Airlines Inc. de Havilland DHC-8-402 aircraft (registration C-GKQA, serial number 4357), operating as flight 533 (POE533), was conducting an instrument flight rules flight from Toronto/Billy Bishop Toronto City Airport, Ontario, to Sudbury Airport, Ontario. A Jazz Aviation LP de Havilland DHC-8-402 aircraft (registration C-GXJZ, serial number 4523), operating as flight 604 (JZA604), was conducting an instrument flight rules flight from Sudbury Airport, Ontario, to Toronto/Lester B. Pearson International Airport, Ontario. POE533 was inbound to Sudbury Airport from the south, with a clearance for a visual approach. JZA604 had taken off from Sudbury Airport under visual flight rules and was heading south. At 1002:21 Eastern Daylight Time, when both aircraft were about 9.5 nautical miles southwest of Sudbury Airport, at approximately 4000 feet above sea level, both flight crews received a resolution advisory from their respective traffic alert and collision avoidance systems. Both flight crews took evasive action, and radar data indicated that the 2 aircraft came within 0.4 nautical miles of each other at the same altitude.

Le présent rapport est également disponible en français.

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1.0 Factual information

1.1 History of the flights

On 14 October 2016, a Porter Airlines Inc. (Porter) de Havilland DHC-8-402 aircraft, operating as flight 533 (POE533), was conducting a scheduled instrument flight rules (IFR)¹ flight from Toronto/Billy Bishop Toronto City Airport (CYTZ), Ontario, to Sudbury Airport (CYSB), Ontario, with 2 flight crew members, 2 cabin crew members, and 11 passengers on board. The captain was in the left seat and was the pilot flying (PF), and the first officer was in the right seat and was the pilot monitoring (PM). POE533 was to arrive from the south, and its estimated time of arrival at CYSB was 1005.²

A Jazz Aviation LP de Havilland DHC-8-402 aircraft, operating as flight 604 (JZA604), was conducting a scheduled IFR flight from CYSB to Toronto/Lester B. Pearson International Airport (CYYZ), Ontario, with 2 flight crew members, 2 cabin crew members, and 58 passengers on board. The captain was in the left seat and was the PM, and the first officer was in the right seat and was the PF. After departure, JZA604 was to head south.

At CYSB, the same runway surface serves as both Runway 04 and Runway 22; its designated number is determined by the direction of takeoff or landing (Appendix A). Runway 22 was the active runway³ when POE533 was approaching CYSB from the south. However, the North Bay controller,⁴ who was located at the Toronto Area Control Centre (ACC), authorized POE533 to fly direct via the PEKVU initial approach waypoint. PEKVU is located at 10.1 nautical miles (nm) final on the area navigation (RNAV) approach⁵ to Runway 04, and is situated on the extended runway centreline for departures from Runway 22 (Figure 1 and Appendix B).

¹ Instrument flight rules is a set of rules governing the conduct of flight under instrument meteorological conditions. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.)

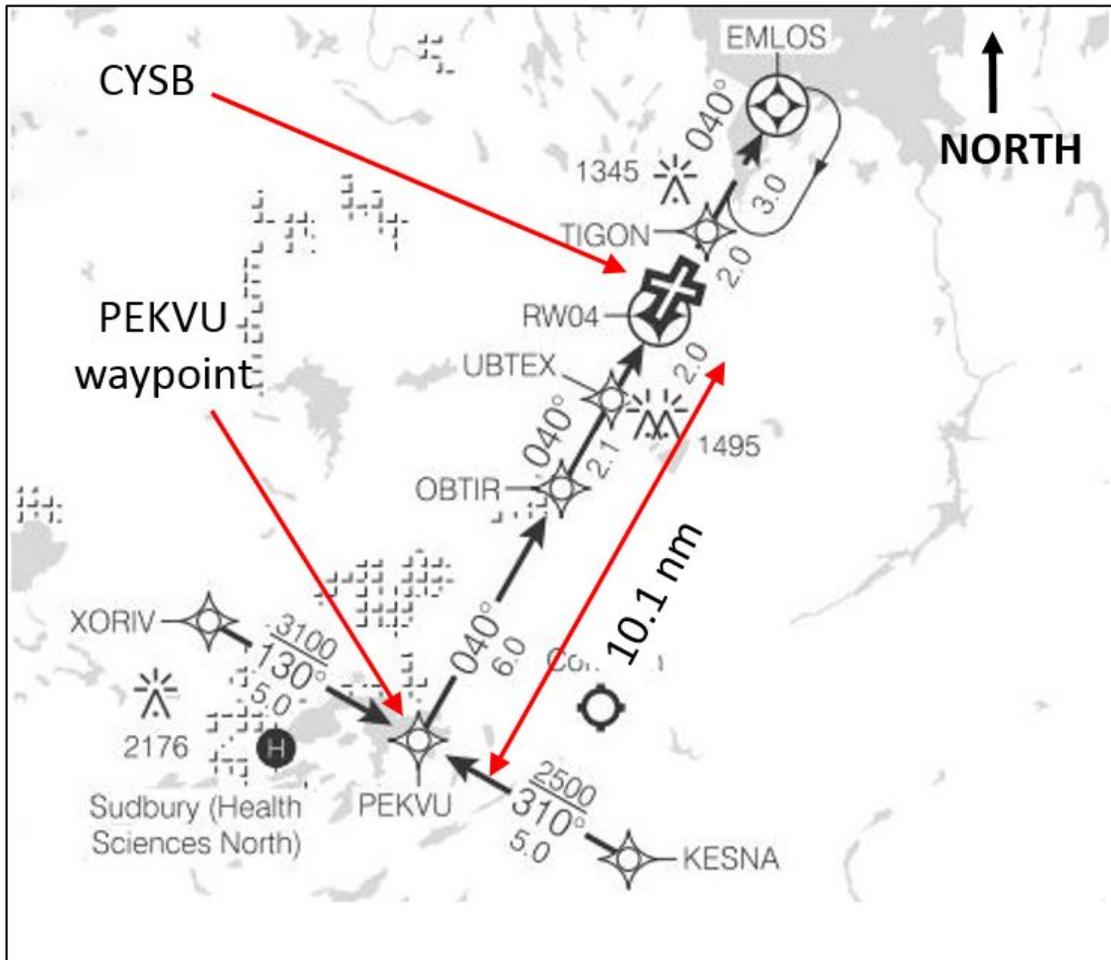
² All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

³ An active runway is any runway currently being used for takeoff or landing. When multiple runways are being used, they are all considered active runways. (NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* [effective 31 August 2016], Glossary.)

⁴ An area controller, such as the North Bay controller, is the duty air traffic controller assigned to a control position in an area control centre. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.) See Section 1.4.2 of this report for more information.

⁵ An RNAV approach is a published IFR approach coded and included in an aircraft's navigation database and published in graphic and textual form to be used by aircraft appropriately equipped to conduct this approach. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.)

Figure 1. Plan view of the RNAV Runway 04 approach chart, showing PEKVU initial approach waypoint (Source: NAV CANADA, *Canada Air Pilot*, Instrument Procedures, Ontario CYSB RNAV [GNSS] RWY 04, with TSB annotations)



POE533 was authorized to descend to 5000 feet above sea level.⁶ Although the aircraft was flying in instrument meteorological conditions (IMC), the flight crew expected to descend below an overcast layer of cloud and conduct a visual approach.⁷

⁶ All altitudes are in feet above sea level unless otherwise noted.

⁷ A visual approach is an approach wherein an aircraft on an IFR flight plan, operating in visual meteorological conditions under the control of air traffic control (ATC) and having ATC authorization, may proceed to the airport of destination. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.)

1.1.1 Sequence of events

At 0944:54, the flight crew of POE533 contacted the Sudbury flight service specialist⁸ and received their initial advisory information for the airport. Upon acknowledging the information, the crew informed the Sudbury specialist that they planned to land on Runway 04 in approximately 20 minutes.

At 0955:26, a transfer of position responsibility began at the North Bay controller position. As per NAV CANADA procedures, the outgoing controller provided a verbal briefing to the incoming controller.

At 0955:27, the JZA604 flight crew contacted the Sudbury specialist and received their initial taxi departure advisory. The specialist informed JZA604 that Runway 22 was the active runway and that a Cessna 172 aircraft was on the runway and would be taking off shortly.

At 0956:23, the JZA604 flight crew informed the Sudbury specialist that they were taxiing and would hold short of Runway 04/22. The Sudbury specialist acknowledged the communication and informed JZA604 that the North Bay controller had not yet approved its departure. JZA604's crew then informed the Sudbury specialist that they were entering the runway and taxiing to position for takeoff from Runway 22.

The Sudbury specialist informed JZA604 that there might be a delay in obtaining approval for it to depart, as there were other IFR aircraft inbound from the south that intended to land on Runway 04. The specialist then asked the crew of JZA604 if they would accept a visual flight rules⁹ (VFR) departure from Runway 22. In accordance with NAV CANADA procedures,¹⁰ the crew of JZA604 requested the VFR departure and continued to taxi on the runway.

The Sudbury specialist requested approval from the North Bay controller to allow JZA604 to conduct a VFR departure from Runway 22. The North Bay controller approved the VFR departure and asked the Sudbury specialist to tell JZA604 to expect an IFR clearance when it was 20 nm south of CYSB. Based on the North Bay controller's experience with previous VFR departures from CYSB, the controller assumed that JZA604 would turn shortly after takeoff to clear the arrival path.

The North Bay controller also asked the Sudbury specialist to inform JZA604 of POE533, which was approximately 26 nm south of the airport, and of a Morningstar Air Express

⁸ A flight service specialist is a certified employee assigned duties and responsibilities at a flight service station. (Source: NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* [effective 31 August 2016], Glossary.) See Section 1.4.1 of this report for more information.

⁹ Visual flight rules are the rules that govern the procedures for conducting flight under visual conditions. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.)

¹⁰ NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* (effective 31 August 2016), VFR Departure of IFR Aircraft, p. 70.

Inc. Cessna Caravan, operating as flight 8056 (MAL8056), which was approximately 21 nm south of the airport. Both aircraft were inbound to land on Runway 04.

At 0958:58, the Sudbury specialist informed the crew of JZA604 that their VFR departure off Runway 22 had been approved, and informed them of POE533's position inbound from the south as well as its intention to land on Runway 04, but did not relay the information regarding MAL8056. The specialist also instructed JZA604 to contact the North Bay controller once airborne.

At 0959:30, when JZA604 became airborne, POE533 was approximately 17.3 nm south of the airport, proceeding directly to the PEKVU initial approach waypoint and descending through 6700 feet.

Ten seconds later, while still in IMC, POE533's flight crew requested further clearance from the North Bay controller, and the controller cleared them for a visual approach to Runway 04. After the crew acknowledged the clearance, the North Bay controller informed them that JZA604 was conducting a VFR departure from Runway 22 and would be instructed to turn to the west, and that MAL8056, which was 10 nm south of the airport, was also inbound to land on Runway 04.¹¹

At 1000:55, the North Bay controller contacted JZA604, and its flight crew advised the controller that they were levelling off at 4000 feet and were approximately 5 nm south of the airport. At that time, POE533 was approximately 14 nm south of the airport and descending through 5800 feet.

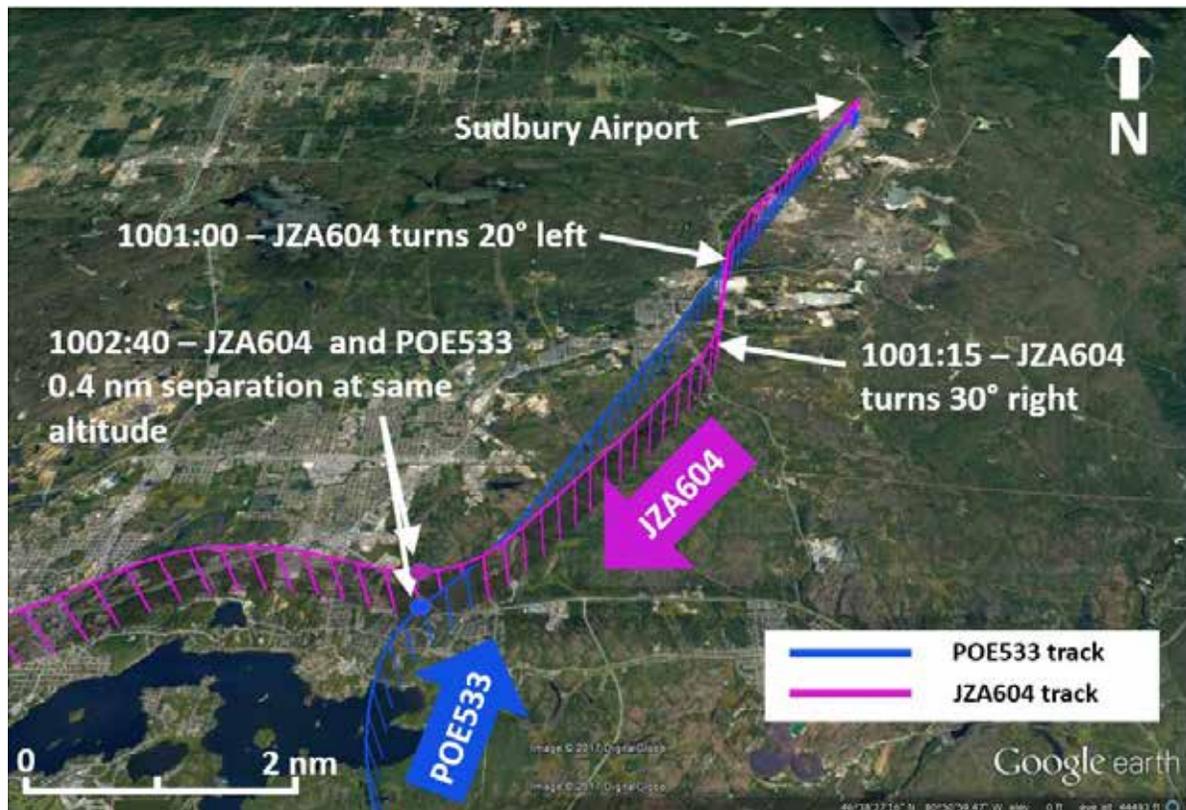
At 1001, JZA604 turned left (east), 20° from the runway extended centreline, which was also the approach path for Runway 04 (Figure 2). The North Bay controller had not been informed of this turn or noticed it on the radar, and subsequently suggested¹² that JZA604 turn 30° to the right (west). The controller then informed JZA604 of POE533's position.

The JZA604 crew responded to the suggestion to turn by stating that they would complete the turn shortly, but were delaying briefly due to some rain showers to the west.

¹¹ This type of traffic information is issued to pilots regarding other known or observed traffic that may be in such proximity to their position or intended route as to warrant their attention. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], Glossary.)

¹² An ACC controller may only vector a VFR aircraft if the pilot requests it, if the controller suggests it and the pilot accepts it, or if the controller considers it necessary for flight safety. (Source: NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], p. 141.)

Figure 2. Flight tracks of JZA604 and POE533 (Source: Google Earth, with TSB annotations)



At 1001:15, JZA604, which was approximately 6.1 nm south of the airport in level flight at 4000 feet, began a turn to the west. POE533 was approximately 12.6 nm south of the airport at this time, descending through 5200 feet.

At 1001:34, the North Bay controller informed the POE533 crew that JZA604 was now at their 1 o'clock position,¹³ flying straight out from Runway 22 at 4000 feet under VFR, and turning to the west.

At 1002:02, the North Bay controller informed POE533 a second time of JZA604's position. JZA604 was still at POE533's 1 o'clock position, 5 miles ahead and flying toward POE533 at 4000 feet. POE533 was approximately 11.5 nm south of the airport and descending through 4800 feet, while JZA604 was approximately 7.5 nm south of the airport.

At 1002:10, the North Bay controller strongly suggested to JZA604's crew that they turn further to the west and informed them that POE533 was at their 12 o'clock position, descending through 4700 feet, 3 miles ahead of them and flying toward them. The JZA604 crew began a 23° bank turn to the right and informed the controller that they were turning west.

¹³ When issuing traffic information to a radar-identified aircraft, the position of the traffic may be described in terms of the 12-hour clock in relation to the aircraft. (Source: NAVCANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* [effective 31 August 2016], p. 59.)

At 1002:11, both POE533 and JZA604 received a traffic alert (TA) from their respective traffic alert and collision avoidance systems (TCASs).¹⁴ The separation between the 2 aircraft was 570 feet vertically and 2.7 nm horizontally, with a closure rate of 330 knots.

At 1002:21, both POE533 and JZA604 received a resolution advisory (RA) from their respective TCASs. The separation between the 2 aircraft was 336 feet vertically and 1.7 nm horizontally.

1.1.2 Responses to traffic alert and collision avoidance system resolution advisories

1.1.2.1 JZA604

When JZA604 was level at 4000 feet, its crew received a TCAS RA instructing them to climb. The first officer disconnected the autopilot in preparation to initiate a climb. At approximately the same time, the captain of JZA604 saw POE533 from the cockpit's left side window and assumed PF duties. The captain initially decided against climbing due to the overcast cloud layer above, and believed that, because the other aircraft was in sight, a turn to the right would be an appropriate evasive manoeuvre.

JZA604 then turned further right and descended about 120 feet before climbing back to 4000 feet. It reached a maximum rate of descent of 1000 feet per minute (fpm), and the right turn increased the aircraft's right bank angle to 40°.

1.1.2.2 POE533

POE533 had been in a 5° bank right turn descending through 4250 feet, with a descent rate of about 1900 fpm, when its crew received a TCAS RA to "maintain vertical speed, crossing, maintain." At the same time, they descended below the overcast layer and saw JZA604.

POE533 briefly reduced its descent rate to 700 fpm. Five seconds later, while descending through 4150 feet, its crew received another TCAS RA, instructing them to "increase descent, increase descent." The crew increased the descent rate, reaching 2500 fpm, and increased the right bank angle to 40°.

At this point, at approximately 1002:27, separation between the 2 aircraft was reduced to 178 feet vertically and 1.1 nm horizontally, with a closure rate of 308 knots.

¹⁴ A TCAS is a type of airborne collision avoidance system based on a family of airborne equipment that functions independently of the ground-based ATC system to detect potential conflicting aircraft that are equipped with secondary surveillance radar transponders. This equipment provides traffic and resolution advisories. (Source: NAV CANADA, *Manual of Air Traffic Services Flight Service Station* [effective 31 August 2016], Glossary.) For further information, refer to Section 1.6 of this report.

1.1.3 Sequence of events following responses to traffic alert and collision avoidance alerts

At 1002:34, POE533's crew informed the North Bay controller that they were turning, and, at 1002:37, JZA604's crew informed the controller that they were climbing. Neither flight crew mentioned that their manoeuvres were in response to TCAS RAs.

At 1002:40, while the 2 aircraft were carrying out the evasive manoeuvres, horizontal separation between them was reduced to 0.4 nm at the same altitude.

At 1002:45, JZA604 informed the North Bay controller that they were clear of the conflict. The controller acknowledged the communication and instructed them to maintain flight under VFR. The controller then instructed POE533 to continue with the visual approach to Runway 04 and to contact the Sudbury specialist on frequency 125.5 MHz.

The North Bay controller subsequently provided JZA604 with its IFR clearance to CYYZ.

Both aircraft continued to their respective destinations without further incident.

Given that the pilots did not report their responses to the TCAS RA as such, air traffic control (ATC) personnel were unaware of the severity of the occurrence and did not contact the TSB immediately. As a result, the cockpit voice recorders were not quarantined in a timely manner and the data was overwritten.

1.2 Meteorological information

The CYSB aerodrome routine meteorological report (METAR) issued at 0900 was as follows: wind 200° true (T) at 3 knots, visibility 20 statute miles, overcast ceiling at 5200 feet above ground level, temperature 5 °C, dew point 3 °C, and altimeter 30.31 inches of mercury.

The METAR issued at 1000 was as follows: wind 210°T at 4 knots, visibility 20 statute miles, overcast ceiling at 4500 feet above ground level, temperature 7 °C, dew point 3 °C, and altimeter 30.31 inches of mercury.

There were no reports of rain showers in the METAR; however, rain showers and/or virga¹⁵ were reported by observers to be in the vicinity of CYSB at the time of the incident.

¹⁵ Virga is water or ice particles falling from a cloud, usually in wisps or streaks, and evaporating completely before reaching the ground. (Source: NAV CANADA, *The Weather of Ontario and Quebec – Graphic Area Forecast 33*, Glossary of Weather Terms, p. 210.)

1.3 *Aerodrome information*

CYSB is an uncontrolled aerodrome with 2 intersecting runways: Runway 04/22 and Runway 12/30 (Appendix A). It has a mandatory frequency area¹⁶ with a radius of 7 nm that is centred on the airport and extends vertically up to and including 4000 feet above sea level.

CYSB's control zone is designated as Class E airspace, in which, according to the *Transport Canada Aeronautical Information Manual* (TC AIM),

Operations may be conducted under IFR or VFR. ATC separation is provided only to aircraft operating under IFR. There are no special requirements for VFR.

[...]

Low-level airways, control area extensions, transition areas, or control zones established without an operating control tower may be classified as Class E airspace.¹⁷

1.3.1 *Runway selection*

Regarding runway selection at an uncontrolled aerodrome, the TC AIM states:

Pilots operating aircraft under IFR or VFR are expected to approach and land on the active runway. The active runway is a runway that other aircraft are using or are intending to use for the purpose of landing or taking off. Should it be necessary for aircraft to approach to, land on, or take off from a runway other than the active runway, it is expected that the appropriate communication between pilots and the ground station will take place to ensure there is no conflict with other traffic. Some pilots operating under VFR at many sites prefer to give commercial IFR and larger type of aircraft priority. This practice, however, is a personal airmanship courtesy, and it should be noted that these aircraft do not establish any priority over other aircraft operating VFR at that aerodrome.¹⁸

1.3.2 *Automatic terminal information service*

According to the TC AIM,

ATIS [automatic terminal information service] is the continuous broadcasting of recorded information for arriving and departing aircraft on a discrete VHF/UHF [very high frequency / ultra high frequency] frequency. Its

¹⁶ A mandatory frequency area is an area established at selected uncontrolled aerodromes within which aircraft are required to comply with mandatory-frequency reporting procedures. (Source: NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* [effective 31 August 2016], Glossary.)

¹⁷ Transport Canada, TP14371, *Transport Canada Aeronautical Information Manual* (TC AIM), RAC – Rules of the Air and Air Traffic Services (13 October 2016), section 2.8.5.

¹⁸ *Ibid.*, section 4.5.2.

purpose is to improve controller [...] effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information.

[...]

Each recording will be identified by a phonetic alphabet code letter, beginning with ALFA. Succeeding letters will be used for each subsequent message.¹⁹

Around the time of the occurrence, CYSB ATIS messages Yankee and Zulu both specified that the preferred runway²⁰ for arriving and departing aircraft was Runway 22.

1.3.3 *Visual flight rules departure of an instrument flight rules aircraft*

Regarding the VFR departure of an IFR aircraft, the TC AIM states the following:

When a delay is experienced in receiving an IFR departure clearance, a pilot may request approval to depart and maintain VFR until an IFR clearance can be received. [...] If the request for a VFR departure is approved, the pilot will be given a time, altitude or location at which to contact ATC for an IFR clearance. Depending upon the reasons for the IFR departure clearance delay, a VFR departure of an IFR flight may not be approved by the IFR unit. In situations such as these, it may be desirable for the pilot to wait for the IFR departure clearance.²¹

When an IFR aircraft departs in accordance with VFR, the flight crew is responsible for ensuring separation from both IFR and VFR traffic.

1.4 *Air traffic services*

1.4.1 *Sudbury Flight Service Station*

NAV CANADA operates a flight service station (FSS) at CYSB. An FSS is “an ATS [air traffic service] unit that provides services pertinent to the arrival and departure phases of flight at uncontrolled aerodromes and for transit through a MF [mandatory frequency] area.”²²

At the time of the occurrence, there was 1 flight service specialist on duty, which was in accordance with unit procedures.

¹⁹ Ibid., section 1.3.

²⁰ The preferred runway is, at an uncontrolled aerodrome, the most suitable operational runway, taking into consideration wind direction and speed, noise abatement restrictions, runway conditions, ground traffic, and any other relevant factor or restriction. (Source: NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* [effective 31 August 2016], Glossary.)

²¹ Transport Canada, *Transport Canada Aeronautical Information Manual* (TC AIM), RAC – Rules of the Air and Air Traffic Services (effective 13 October 2016), section 6.2.2.

²² NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* (effective 31 August 2016), Glossary.

1.4.2 *Toronto Area Control Centre*

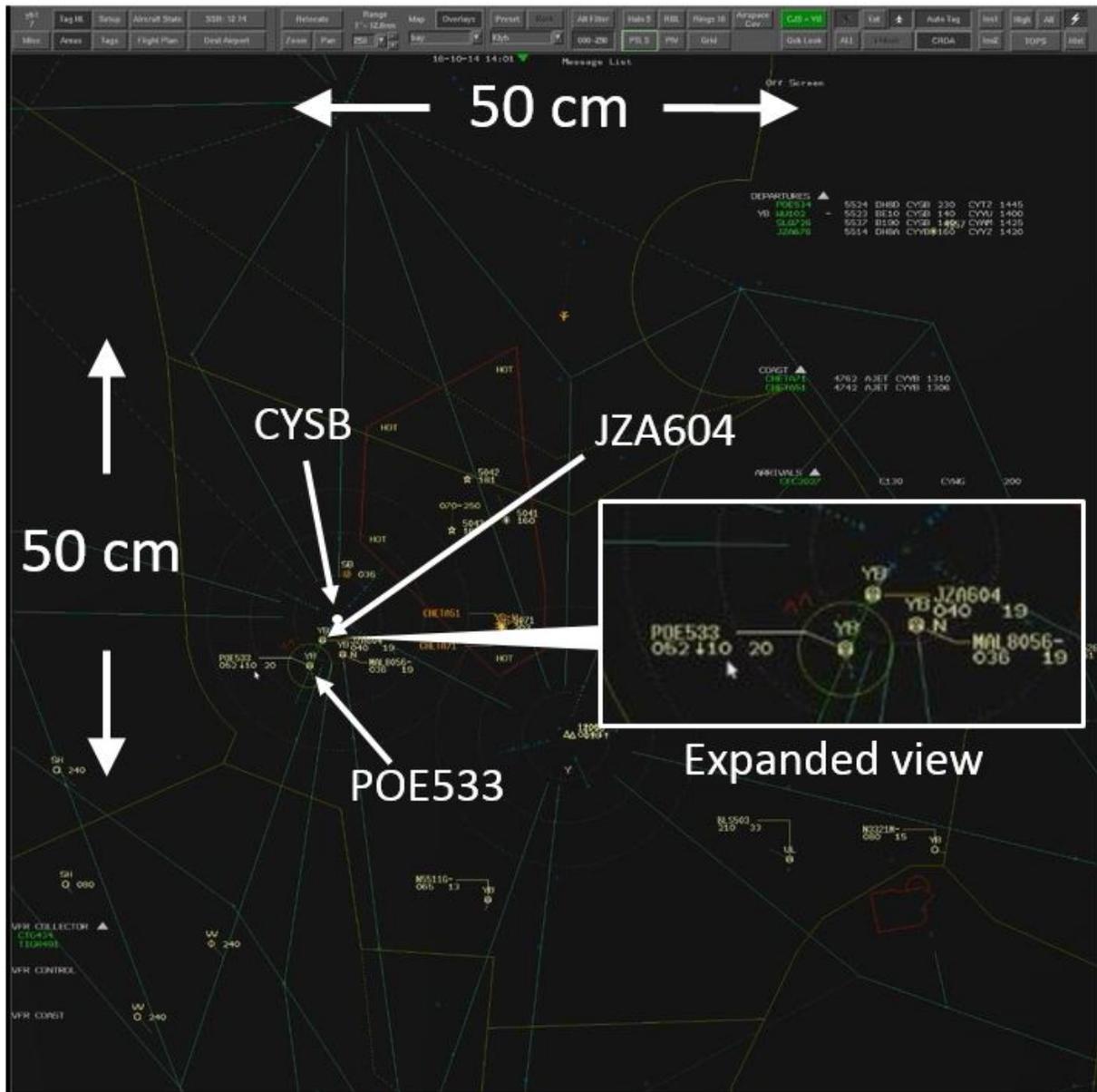
The Toronto ACC is responsible for the controlled airspace within an area defined in the *Toronto ACC Unit Operations Manual*, and covers the airspace over most of Ontario and some parts of Quebec. The area is divided into several specialties, which are further divided into sectors. The North Bay Sector is part of the North Bay Specialty, and is responsible for aircraft operating under IFR into and out of CYSB, as well as North Bay/Jack Garland Airport (CYYB), Ontario; Emsdale Airport (CNA4), Ontario; and Saint-Bruno-de-Guigues Aerodrome (CTA4), Quebec.

At the time of the occurrence, in accordance with unit procedures, there was 1 area controller in position, who was responsible for the North Bay Sector.

The North Bay Sector is equipped with a Canadian Automated Air Traffic System situation display (CSiT), which is a screen measuring approximately 50 cm by 50 cm. The settings on the display can be adjusted by individual controllers to suit personal preferences. Among the adjustable items are the amount of information displayed for each aircraft's present-position symbol, or target; the brightness of groups of targets; and the scope or range of the radar.

At the time of the occurrence, the CSiT used by the North Bay controller displayed altitude information for both POE533 and JZA604, along with their present-position symbols. Given the large area of the North Bay Sector, the CSiT range was set to 250 nm, whereby 1 cm of screen resolution was equal to approximately 5 nm. This setting enabled the controller to see the entire sector (Figure 3). However, if a target makes a small heading change while the range is set to this scale, it will not be immediately apparent on the screen.

Figure 3. Screenshot of the North Bay controller’s Canadian Automated Air Traffic System situational display at 1001:30 (Source: NAV CANADA, with TSB annotations)



An operational information display system located at the controller’s workstation displays the active runway for CYSB. At the time of the occurrence, it indicated that the active runway was Runway 22.

The volume and complexity of air traffic in the North Bay Sector at that time was considered low.

1.4.3 *Flight service station procedures*

The NAV CANADA *Manual of Air Traffic Services – Advisory Services – Flight Service Station* provides guidance on runway selection at airports that have an FSS. The manual states that a preferred runway²³ should be identified when wind speed is 5 knots or greater, and that

a runway becomes an active runway after an airport advisory has been provided, and the pilot confirms use of the runway. A runway ceases to be active when the arriving aircraft has exited the runway after landing or when the departing aircraft becomes airborne.²⁴

Flight service specialists do not have the authority to designate the runway to be used by aircraft. That is the pilot's responsibility.

The sequence for issuing a taxi departure advisory to an aircraft that is taxiing or that reports readiness for departure is also specified in the *Manual of Air Traffic Services – Advisory Services – Flight Service Station*. The flight service specialist is required to provide advisory information to the aircraft regarding both air and ground traffic on initial contact, or in sufficient time for the information to be of use.²⁵

The initial taxi advisory issued to JZA604 included information regarding a Cessna 172 that was departing from Runway 22. However, there was no mention of POE533 or MAL8056, which were inbound from the south for landing on Runway 04.

1.4.4 *North Bay Specialty procedures*

1.4.4.1 *Inter-unit arrangement*

CYSB is located within a Class E control zone, meaning that IFR aircraft are controlled and VFR aircraft are not controlled. Responsibilities for coordinating the movements of IFR and VFR aircraft at CYSB are specified in an inter-unit arrangement between the Toronto ACC and the Sudbury FSS.

With respect to arriving aircraft, the inter-unit arrangement states that the ACC shall, "during VMC [visual meteorological conditions], confirm the runway in use with the FSS prior to clearing an aircraft for an approach to a specific runway."²⁶ However, there was no communication between the ACC and the FSS regarding the active runway at CYSB prior to the North Bay controller's clearance of POE533 to the PEKVU initial approach waypoint on the approach to Runway 04.

²³ "A preferred runway is based primarily on the runway most nearly aligned with the wind direction when the wind speed is 5 knots or more." (Source: NAV CANADA, *Manual of Air Traffic Services – Advisory Services – Flight Service Station* [effective 31 August 2016], p. 83.)

²⁴ Ibid.

²⁵ Ibid., p. 98.

²⁶ Arrangement between Toronto Area Control Centre and Sudbury Flight Service Station for the Coordination of ATS Procedures (effective 31 March 2016), section D.1.1(D).

Although the active runway was displayed at the controller's workstation, it was not common practice to use this information. Rather, it was the practice of both controllers involved to clear IFR aircraft for the requested approach when VFR conditions prevailed.

1.4.4.2 *Transfer of position responsibility*

Just prior to the occurrence, a transfer of position responsibility had taken place at the North Bay Sector. When carrying out this handoff of duties, the outgoing controller is required to "provide a verbal briefing to the relieving controller using the transfer of position checklist."²⁷

Item 6 of the North Bay Sector checklist requires the outgoing controller to brief the incoming controller on the approach in use, the runway in use, and the current ATIS information for the airports. Although the incoming controller was briefed during the transfer on the use of visual approaches once aircraft were below 5000 feet and on POE533's authorization to fly via PEKVU for landing on Runway 04, the preferred or active runway at CYSB was not discussed.

1.4.4.3 *Clearance for visual approach*

The NAV CANADA *Manual of Air Traffic Services – Control Services – Area Control Centre* provides specific guidelines regarding when controllers may authorize an aircraft to conduct a visual approach. The guidelines specify that in "single-approaching-aircraft situations, the pilot [must report] sighting the airport"²⁸ before a controller can authorize it for a visual approach.

In this occurrence, the North Bay controller authorized POE533 for a visual approach to Runway 04 without confirming that the flight crew had the airport in sight. The crew accepted the authorization although POE533 was still flying in cloud and they lacked visual reference to the ground or the airport.

1.5 *Personnel*

All pilots and air traffic services personnel involved in the occurrence were certified and qualified for their respective positions in accordance with existing regulations, and all were considered sufficiently experienced for their current roles (Table 1 and Table 2).

²⁷ NAV CANADA, *Manual of Air Traffic Services – Control Services – Area Control Centre* (effective 31 August 2016), p. 17.

²⁸ *Ibid.*, p. 103.

Table 1. Experience of flight crew

Flight crew	Organization	Total flight time (hours)	Flight time on the DHC-8-402 (hours)
JZA604 captain	Jazz Aviation LP	21 000	600
JZA604 first officer	Jazz Aviation LP	2800	600
POE533 captain	Porter	6000	3000
POE533 first officer	Porter	6000	1200

Table 2. Experience of air traffic services personnel

Air traffic services	Organization	Experience (years)
CYSB flight service specialist	NAVCANADA	1
North Bay incoming controller	NAVCANADA	25
North Bay outgoing controller	NAVCANADA	34

1.6 Traffic alert and collision avoidance system

1.6.1 General

Both aircraft were equipped with TCAS, which detects potentially conflicting aircraft using secondary surveillance radar transponder signals and provides advice to the flight crews of the aircraft involved. The system's advice is rendered on 2 levels: via TAs and RAs. A TA advises a flight crew of potential traffic conflicts, whereas an RA alerts the crew to an actual conflict and provides advice on manoeuvres to avoid collision. Both TAs and RAs provide visual and verbal alerts. As described in the TC AIM:

- (a) TAs provide information on proximate traffic and indicate the relative positions of intruding aircraft. TAs are intended to assist flight crew in visual acquisition of conflicting traffic and to prepare pilots for the possibility of an RA.
- (b) RAs are divided into two categories: preventative advisories, which instruct the pilot to maintain or avoid certain vertical speeds; and corrective advisories, which instruct the pilot to deviate from the current flight path (e.g. "CLIMB" when the aircraft is in level flight).²⁹

²⁹ Transport Canada, *Transport Canada Aeronautical Information Manual (TC AIM), COM—Communications, Navigation and Surveillance* (effective 13 October 2016), section 9.1.

A TCAS RA is based on a 5-second crew reaction time, unless the advisory is a reversal or an increase in strength of the original, in which case it is based on a reaction time of 2.5 seconds.³⁰

According to the Bombardier Q400 *Aeroplane Operating Manual*, there are 12 different TCAS RA annunciations, which use both aural commands and visual cues.³¹ The most common aural commands are “climb, climb” and “descend, descend.”

The RA “maintain vertical speed, crossing, maintain” is a preventive RA: it instructs a flight crew to maintain their current vertical speed and indicates that the aircraft’s own flight path will cross that of the intruder.

On multiple aircraft equipped with TCAS, the system

will coordinate their resolution advisories [...]. The coordination ensures that complementary advisories are issued to each aircraft. The crews should promptly but smoothly follow the advisory [and] never maneuver in the opposite direction.³²

1.6.2 Visual display of traffic and resolution advisories

The navigation setting on the multi-function display (MFD) can be configured to show traffic in automatic (pop-up) mode or continuous mode. The automatic mode shows only TA and RA indications, while the continuous mode shows all aircraft traffic, whether or not those aircraft constitute a threat.³³

During an RA, the primary flight display shows the required rates of climb or descent on the instantaneous vertical speed indicator.³⁴

After the transponder is initially selected ON, the TCAS display on the MFD defaults to the automatic mode. To view traffic in continuous mode, the flight crew must press the TCAS button, select the range to 40 nm or below on the electronic flight information system control panel, and ensure that the navigation page is selected to ARC or MAP mode.³⁵

³⁰ Honeywell International Inc., *CAS 67A/67B Collision Avoidance System Pilot’s Guide*, Revision 3 (effective date April 2013), p. 11.

³¹ Bombardier Aerospace, *Aeroplane Operating Manual (AOM)*, Volume 1, Revision 11 (04 July 2014), p. 2.14-2.

³² Ibid.

³³ Flight Safety International, *Q400 Dash 8 – Flight Crew Operating Manual (FCOM)*, Volume 2, Revision 5 (January 2008), p. 6-78.

³⁴ Ibid.

³⁵ Bombardier Aerospace, *Aeroplane Operating Manual (AOM)*, Volume 4, Revision 11 (04 July 2014), p. 6.15-5.

1.6.2.1 *Porter Airlines Inc.*

The cruise-related portion of Porter's standard operating procedures (SOPs) specifies that flight crews "should select a MFD map range of 40 nm or less to ensure full time viewing of potential targets."³⁶ While this instruction is not specifically mentioned in the descent-related section of the SOPs, Porter flight crews are trained to keep the range at 40 nm or less during an approach in order to have a complete picture of the approach display and traffic information.

During the occurrence flight, prior to the RA, both POE533 crew members had their respective TCAS settings configured to display continuous traffic.

1.6.2.2 *Jazz Aviation LP*

Jazz Aviation LP does not have SOPs pertaining to the full-time viewing of potential targets, which is at the discretion of flight crews.

During departure, the TCAS setting of the captain of JZA604 was configured to its default automatic mode. The TCAS setting of the first officer was set to continuous mode during departure and until the aircraft reached about 2200 feet, at which time the TCAS was switched to automatic mode; it was switched back to continuous mode 50 seconds before the RA.

1.6.3 *Procedures for responding to resolution advisories*

1.6.3.1 *General guidance*

Information provided to pilots in the TC AIM emphasizes the importance of following a TCAS RA. It states:

- (c) Flight crews are reminded to follow the resolution advisories (RAs) promptly and accurately, even though the RAs may change in strength and/or reverse. RA commands do not require large load factors when being followed. Any delay in responding to an RA could swiftly erode the ability to maintain or achieve adequate separation without resorting to strengthening RAs. For TCAS to provide safe vertical separation, initial vertical speed response is required within five seconds of the RA. Deviation from commands or second-guessing the commands should not occur. An RA prevails over any air traffic control (ATC) instruction or clearance. [...]
- (g) TAs and RAs should be treated as genuine unless the intruder has been positively identified and assessed as constituting neither a threat nor a hazard.³⁷

³⁶ Porter Airlines Inc., *Standard Operating Procedures (SOPs)*, Revision 12, 01 December 2016, Chapter Two—Normal Procedures, Section 2.13—Cruise, p. 54.

³⁷ Transport Canada, *Transport Canada Aeronautical Information Manual (TC AIM)*, COM—Communications (effective 13 October 2016), section 9.6.

Under the *Canadian Aviation Regulations* (CARs),

602.31 (3) The pilot-in-command of an aircraft may deviate from an air traffic control clearance or an air traffic control instruction to the extent necessary to carry out a collision avoidance manoeuvre, if the manoeuvre is carried out

(a) in accordance with a resolution advisory generated by an ACAS; or

(b) in response to an alert from a TAWS [Terrain Awareness Warning System] or a Ground Proximity Warning System (GPWS).³⁸

The United States Federal Aviation Administration issued an Advisory Circular (AC) that emphasizes the importance of following a TCAS RA with regard to ATC clearances and instructions. It states:

If a TCAS RA requires maneuvering contrary to right-of-way rules, cloud clearance rules for visual flight rules (VFR), instrument flight rules (IFR), or other such criteria, pilots should follow the TCAS RAs to resolve the immediate traffic conflict. Pilots should keep deviations from rules or clearances to the minimum necessary to satisfy a TCAS RA.³⁹

1.6.3.2 Porter Airlines Inc.

Porter's SOPs include steps for an aircraft's PF and PM to follow when responding to an RA. They emphasize compliance with an RA regardless of visual contact with traffic, and do not allow for pilot discretion:

Compliance with TCAS RESOLUTION ADVISORY commands is mandatory. It is possible to confuse other traffic in close proximity with an unseen aircraft which is the real threat.

FOLLOW THE RA!⁴⁰

The procedures call for the PF to "disconnect the autopilot and initiate a climb or descent as required to follow the TCAS avoidance maneuver."^{41,42}

³⁸ Transport Canada, SOR/96-433, *Canadian Aviation Regulations* (CARs) (last amended 15 September 2017), subsection 602.31(3).

³⁹ U.S. Federal Aviation Administration, Advisory Circular (AC) No. 120-55C, *Air Carrier Operational Approval and Use of TCAS II*, 18 March 2013, p. 10.

⁴⁰ Porter Airlines Inc., *Standard Operating Procedures* (SOPs), Revision 11, 01 May 2015, Chapter Three – Abnormal Procedures, section 3.7, p. 26 [emphasis in original].

⁴¹ Ibid.

⁴² Porter Airlines Inc., *Flight Operations Manual* (FOM), Revision 4, 01 March 2016, Chapter Three – Operational Procedures, section 3.24.5, p. 68.

1.6.3.3 Jazz Aviation LP

Jazz Aviation LP's *Company Operations Manual* also specifies that compliance with a TCAS RA is mandatory; however, it allows for some discretion if flight crew members believe that they have more accurate information, such as confirmed visual contact with the intruding aircraft. The manual states:

Compliance with TCAS RESOLUTION ADVISORY (RA) commands is mandatory unless, in the opinion of the Captain, doing so would compromise the safe operation of the flight, or unless the Flight Crew has more accurate information (e.g. confirmed visual contact) about the intruder causing the RA.

Warning: Use extreme caution when ignoring TCAS traffic as the traffic is visual. The safest course of action is to follow the RA as the visual traffic may not be the TCAS targeted traffic in congested airspace.⁴³

The *Company Operations Manual* elaborates on why it may be dangerous to elect not to comply with an RA based on visual identification of the traffic, cautioning that

- a) The crew may have visually acquired the wrong aircraft; and
- b) It may be difficult to judge the vertical and/or horizontal displacement of the suspected aircraft. This is especially true when at cruise altitude or when the horizon is obscured or distorted by cloud layers.⁴⁴

Jazz Aviation LP's SOPs require that the PF respond immediately to an RA by disengaging the autopilot and "promptly and smoothly [adjusting] the pitch/vertical rate to match the commands displayed"⁴⁵ on the instantaneous vertical speed indicator.

1.6.4 Communication following a resolution advisory

Guidance provided to pilots in the TC AIM and in Transport Canada's AC 700-004 – *Airborne Collision Avoidance System Advisory Material* specifies that, when receiving a TCAS RA, "pilots should notify the appropriate ATC unit, as soon as possible, of the deviation, and when the deviation has ended."⁴⁶

Both the TC AIM and the AC recommend using phraseology contained in the International Civil Aviation Organization's *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM) (Doc 4444), which came into effect in November 2007. Specifically, it calls for pilots to report "TCAS RA" when responding to the advisory and "clear of conflict, returning to (assigned clearance)" when returning to the initial clearance or instruction.

⁴³ Jazz Aviation LP, *Company Operations Manual*, Revision 19, 01 May 2016, p. 8.8-7.

⁴⁴ Ibid.

⁴⁵ Ibid., p. 8.8-9.

⁴⁶ Transport Canada, Advisory Circular (AC) 700-004, *Airborne Collision Avoidance System Advisory Material* (Issue 02: 03 June 2013), p. 10.

The SOPs of both Jazz Aviation LP and Porter also require the PM to communicate with ATC during a TCAS RA event. However, both airlines stipulate TCAS phraseology that differs from that recommended by TC and the International Civil Aviation Organization. If a vertical deviation is called for, the airlines' required phraseology is "(call sign), TCAS climb (or descent)."^{47,48}

This phraseology, which is based on previous International Civil Aviation Organization recommendations to announce the direction of a vertical deviation during an RA, has occasionally led to ambiguity, according to an article by EUROCONTROL.⁴⁹ It states that, because no phraseology existed to report some common RAs (such as "adjust vertical speed"), "pilots often improvised their reports creating extra confusion in the situation that was already stressful for the controller."⁵⁰

1.6.5 Resolution advisory response training

Porter's initial TCAS training syllabus includes simulator training for a climb or descend RA; the recurrent training syllabus includes simulator training for a descend RA, followed by a reversal for a "climb now" RA. Other types of TCAS RA commands are not covered in the simulator training. Both initial and recurrent TCAS events are conducted in IMC.

The initial and recurrent training syllabuses of Jazz Aviation LP include simulator training for an RA in IMC conditions, but do not mention the specific commands associated with the RA training.

1.7 Shared situational awareness

Situational awareness has been defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future."⁵¹ Three essential levels of situational awareness that are critical for effective performance in dynamic environments are cited in this definition. That is, performance that effects a desired result relies on an individual's ability to take in information (perception) and to understand both its meaning (comprehension) and its implications for the future of the operation (projection).

⁴⁷ Porter Airlines Inc., *Flight Operations Manual (FOM)*, Revision 4, 01 March 2016, Chapter Three – Operational Procedures, Section 3.24.5, p. 68.

⁴⁸ Jazz Aviation LP, *Company Operations Manual*, Revision 19, 01 May 2016, p. 8.8-9.

⁴⁹ EUROCONTROL, *HindSight No. 6*, Changes to ICAO Rules Regarding TCAS RAs, January 2008, p. 14.

⁵⁰ Ibid.

⁵¹ M. R. Endsley, "Theoretical underpinnings of situation awareness: a critical review," in: M. R. Endsley and D. J. Garland (eds.), *Situation Awareness Analysis and Measurement* (Mahwah, NJ: Lawrence Erlbaum, 2000), p. 6.

Shared situational awareness requires members of a team to anticipate how they will coordinate their actions to meet a shared goal, and is a function of 2 elements: each team member's own degree of situational awareness, and the degree of shared understanding among team members.⁵² Communication and sharing of information are critical to the development of shared understanding.

1.8 *TSB laboratory reports*

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

- LP269/2016 – FDR [flight data recorder] Data Analysis

⁵² K. A. Wilson, J. W. Guthrie, E. Salas, and W.R. Howse, "Team process," in: J. A. Wise, V. D. Hopkin, and D. J. Garland (eds.), *Handbook of Aviation Human Factors*, 2nd Edition (Boca Raton, FL: Taylor and Francis, 2010), p. 9-4.

2.0 Analysis

All personnel involved in the occurrence were certified and qualified in accordance with existing regulations, and nothing was found to indicate that there was any aircraft failure or system malfunction that contributed to the occurrence before or during the flights. The analysis will focus on the shared situational awareness of involved personnel with respect to traffic coordination, procedures, training, and communication.

2.1 Shared situational awareness

2.1.1 General

Maintaining situational awareness requires an individual to take in information from the environment, determine its significance, and project its importance for the future. The sharing of information deemed operationally significant is critical to the realization of a common understanding, or shared situational awareness, among members of a team regarding how tasks are to be accomplished.

In this occurrence, assumptions were made by the individuals involved that inhibited the sharing of operationally significant information and impeded the attainment of a shared situational awareness regarding how traffic would be effectively managed.

2.1.2 Sudbury flight service specialist

As the area around Sudbury Airport (CYSB) is designated as Class E airspace, instrument flight rules (IFR) movements are controlled and visual flight rules (VFR) movements are not controlled. Although arrival and departure runways are not assigned, both IFR and VFR inbound aircraft are expected to conform to the existing traffic pattern by approaching and landing on the active runway – the one that other aircraft are using or intending to use. Should use of a runway other than the active runway become necessary, the pilots and ground stations involved are expected to communicate effectively to ensure that its use will not result in traffic conflict.

The Sudbury flight service specialist's initial taxi departure advisory to Jazz Aviation LP flight 604 (JZA604) did not include information regarding inbound opposite-direction IFR traffic. As a result, the JZA604 flight crew was not fully aware of the traffic situation when it taxied to position on Runway 22.

While the inbound IFR traffic was still some distance from the airport when the Sudbury specialist provided the initial taxi advisory, the exclusion of that information meant that the JZA604 flight crew missed an opportunity to incorporate knowledge of the opposite-direction IFR traffic into their awareness of the traffic situation around CYSB.

2.1.3 *North Bay controllers*

2.1.3.1 *Approval of approach to Runway 04*

The inter-unit arrangement between the Sudbury Flight Service Station (FSS), which is responsible for airport advisory service within the control zone, and the Toronto Area Control Centre, which is responsible for the control of IFR traffic, specified that the active runway was to be taken into account when clearing arriving aircraft for approach.

At the time of the occurrence, Runway 22 was designated as the preferred runway on the Sudbury automatic terminal information service, and was the runway on which VFR traffic was conducting circuits.

Contrary to the provisions of the inter-unit arrangement, the North Bay controller who was in position before the risk of collision occurred did not confirm the active runway with the Sudbury specialist before clearing Porter Airlines Inc. flight 533 (POE533) direct to PEKVU, a waypoint on the approach to Runway 04.

It was not common practice for North Bay controllers to use displayed information regarding the active runway at CYSB. Rather, when clearing IFR aircraft while VFR conditions prevailed, it was the practice of both controllers involved to issue clearance for the approach requested by the pilot. The North Bay controllers' practice of clearing IFR aircraft for an approach without regard to the active runway at CYSB created a situation wherein arriving IFR traffic was counter to the flow of, and therefore more likely to come into conflict with, VFR traffic operating at the airport.

2.1.3.2 *Approval of opposite-direction visual flight rules departure*

The fact that Runway 22 was the active and preferred runway at CYSB was not included in the briefing provided to the incoming North Bay controller during the transfer of position responsibility. Moreover, the outgoing North Bay controller did not take into account the active runway at CYSB when planning for IFR arrivals. The briefing was focused on 2 IFR arrivals that were inbound for the reciprocal Runway 04. As a result, the incoming controller was not aware that the IFR arrivals were proceeding counter to VFR traffic at the airport. It was not until the request was made for JZA604 to depart under VFR from Runway 22 that the incoming controller became aware of the possibility of opposite-direction traffic.

When approving the VFR departure of JZA604, the incoming North Bay controller assumed, based on previous experience with VFR departures from CYSB, that if the flight crew had knowledge of the inbound traffic, they would turn shortly after takeoff to clear the arrival path. However, the controller did not instruct the Sudbury specialist to communicate this expectation to JZA604. Rather, when approving the VFR departure, the North Bay controller instructed the Sudbury specialist to ensure that JZA604 was aware that POE533 was on approach to Runway 04 and that Morningstar Air Express Inc. flight 8056 (MAL8056) was also inbound for Runway 04. The Sudbury specialist advised JZA604 of POE533, but did not pass on the information about MAL8056.

When accepting a VFR departure, flight crews are responsible for ensuring their own separation from IFR and VFR aircraft. Therefore, the controller left it to the JZA604 flight crew to determine the most effective means of avoiding POE533, which was on approach.

The North Bay controller approved the VFR departure of JZA604 without a coordinated plan to prevent a conflict between the aircraft and opposite-direction traffic.

2.1.3.3 *Visual approach clearance*

POE533 requested further clearance when approaching 5000 feet, while still in instrument meteorological conditions (IMC). The North Bay controller was not aware that the aircraft was in IMC at the time.

Following that request, the incoming North Bay controller cleared POE533 for a visual approach to Runway 04 without confirmation that the flight crew had the airport in sight. This decision was likely based on the fact that, during the transfer of position responsibility briefing that took place moments before, the controller had been informed that visual approaches could be conducted once aircraft were below 5000 feet.

The visual-approach clearance issued by the North Bay controller and accepted by the POE533 flight crew while the aircraft was in IMC likely led to an expectation by the controller that JZA604 and POE533 would be able to see and avoid each other.

2.1.3.4 *Suggestion to turn*

Following departure, the JZA604 flight crew initiated a 20° heading change to the left (east), which was in the direction of their destination and away from rain showers to the west of the airport. The crew did not communicate to the North Bay controller that they intended to turn left, nor were they required to communicate this.

JZA604's left turn was not apparent on the North Bay controller's Canadian Automated Air Traffic System situation display because the display was operating on a scale of 250 nautical miles.

As a result, the North Bay controller was unaware that JZA604 was east of the Runway 04 extended centreline, and suggested that the aircraft turn 30° right, essentially bringing it back toward the approach path for Runway 04.

2.2 *Traffic alert and collision avoidance system*

2.2.1 *Setup of visual traffic display*

The DHC-8-402 aircraft is equipped with a traffic alert and collision avoidance system (TCAS) interface that can be configured in either of 2 different modes: the default automatic (pop-up) mode, in which traffic is not displayed unless it is the subject of a traffic alert or resolution advisory (RA); or the continuous mode, which allows for full-time viewing of the traffic.

During the occurrence flight, prior to the RA, both POE533 crew members had their respective TCAS settings configured to display continuous traffic, as per Porter Airlines Inc. standard operating procedures (SOPs).

Jazz Aviation LP did not have SOPs for the selection of TCAS continuous and automatic modes. During the occurrence, the captain's traffic display was still in default automatic mode and, as a result, the captain did not have a complete understanding of POE533's position and altitude.

2.2.2 Responses to resolution advisories

2.2.2.1 JZA604

Although JZA604 was operating under VFR and had not yet been authorized to enter IMC, manoeuvring contrary to an air traffic control (ATC) instruction or clearance is permitted under *Canadian Aviation Regulations* (CARs) subsection 602.31(3) when its purpose is to comply with a TCAS RA. At approximately the same time that the RA instruction to climb was received, the captain of JZA604 made visual contact with POE533. Given that JZA604 would likely have encountered IMC if a climb had been executed, the captain believed that turning would be the most appropriate evasive manoeuvre.

The captain's decision to deviate from the advisory was permitted by Jazz Aviation LP SOPs, which allow visual manoeuvring contrary to an RA instruction if a flight crew perceives information that they believe to be more accurate, such as by having the aircraft in sight.

As a result of these factors, the JZA604 captain manoeuvred the aircraft contrary to the RA instructions. Although permitted by company SOPs, this alternate manoeuvre reduced the vertical separation between the 2 aircraft.

Jazz Aviation LP TCAS simulator training scripts are not specific to the types of RA commands that flight crews receive during simulator training. As a result, flight crews may be inexperienced in some of the less common RAs, and may manoeuvre contrary to an RA or have a delayed reaction.

2.2.2.2 POE533

Following the TCAS RA to "maintain vertical speed, crossing, maintain," the immediate reaction of POE533's flight crew was to reduce their rate of descent. That response resulted in a subsequent RA to descend, with which the crew complied. The intent of the initial advisory was that the crew should continue descending at the current rate.

The Porter Airlines Inc. TCAS simulator training syllabus and scripts do not address RA commands other than climb and descend and their associated reversals. As a result, the captain of POE533 was likely inexperienced in the initial RA instruction to maintain vertical speed, and manoeuvred contrary to the command, which reduced the vertical separation between the 2 aircraft.

2.2.3 *Communication following a resolution advisory*

Neither of the 2 flight crews used the required phraseology to clearly communicate to ATC that they were responding to a TCAS RA. Instead, both flight crews reported only the evasive manoeuvres they were taking: the crew of JZA604 reported that they were climbing, and the POE533 crew reported that they were turning. According to the SOPs of both airlines, the correct phraseology was “(call sign), TCAS climb (or descent).” Consequently, ATC personnel were unaware that a TCAS RA event had occurred. If flight crews do not report to ATC that manoeuvres are being executed as a result of a TCAS RA, controllers may be uncertain about an aircraft’s intentions and issue contradictory instructions, increasing the risk of collision.

Further, the operators’ TCAS RA phraseology differs from what is currently recommended by the International Civil Aviation Organization and Transport Canada. The phraseology currently in use by both operators calls for a TCAS event to be reported only as a TCAS-commanded climb or descent, and does not provide guidance on phraseology when following TCAS advice to maintain or adjust vertical speed.

If guidance provided to flight crews by operators includes phraseology that is not consistent with international best practices, ambiguous information regarding aircraft manoeuvring may be reported to ATC, increasing the risk of collision.

Given that the pilots did not report their responses to the TCAS RA as such, ATC personnel were unaware of the severity of the occurrence and did not contact the TSB immediately. As a result, the TSB did not have the data from the cockpit voice recorders quarantined in a timely manner, and the occurrence data was overwritten. If reporting of occurrences to the TSB is delayed, there is a risk that the cockpit voice data necessary to identify and communicate safety deficiencies will be unavailable.

3.0 Findings

3.1 Findings as to causes and contributing factors

1. The North Bay controllers' practice of clearing instrument flight rules (IFR) aircraft for an approach without regard to the active runway at Sudbury Airport, Ontario, created a situation wherein arriving IFR traffic was counter to the flow of, and therefore more likely to come into conflict with, visual flight rules traffic operating at the airport.
2. The Sudbury flight service specialist's initial taxi departure advisory to Jazz Aviation LP flight 604 (JZA604) did not include information regarding inbound opposite-direction IFR traffic. As a result, the JZA604 flight crew was not fully aware of the traffic situation when it taxied to position on Runway 22.
3. The North Bay controller approved the visual flight rules departure of JZA604 without a coordinated plan to prevent a conflict between the aircraft and opposite-direction traffic.
4. The visual-approach clearance issued by the North Bay controller and accepted by the Porter Airlines Inc. flight 533 (POE533) flight crew while the aircraft was in instrument meteorological conditions likely led to an expectation by the controller that JZA604 and POE533 would be able to see and avoid each other.
5. JZA604's left turn was not apparent on the North Bay controller's Canadian Automated Air Traffic System situation display because the display was operating on a scale of 250 nautical miles.
6. The North Bay controller was unaware that JZA604 was east of the Runway 04 extended centreline, and suggested that the aircraft turn 30° right, essentially bringing it back toward the approach path for Runway 04.
7. Jazz Aviation LP did not have standard operating procedures for the selection of the traffic alert and collision avoidance system (TCAS) continuous and automatic modes. During the occurrence, the captain's traffic display was still in default automatic mode and, as a result, the captain did not have a complete understanding of POE533's position and altitude.
8. Following the TCAS resolution advisory (RA), the JZA604 captain manoeuvred the aircraft contrary to the RA instructions. Although permitted by company standard operating procedures, this alternate manoeuvre reduced the vertical separation between the 2 aircraft.
9. The Porter Airlines Inc. TCAS simulator training syllabus and scripts do not address RA commands other than climb and descend and their associated reversals. As a result, the captain of POE533 was likely inexperienced in the initial RA instruction to

maintain vertical speed, and manoeuvred contrary to the command, which reduced the vertical separation between the 2 aircraft.

3.2 *Findings as to risk*

1. If flight crews do not report to air traffic control that manoeuvres are being executed as a result of a TCAS RA, controllers may be uncertain about an aircraft's intentions and issue contradictory instructions, increasing the risk of collision.
2. If guidance provided to flight crews by operators includes phraseology that is not consistent with international best practices, ambiguous information regarding aircraft manoeuvring may be reported to air traffic control, increasing the risk of collision.
3. If reporting of occurrences to the TSB is delayed, there is a risk that the cockpit voice data necessary to identify and communicate safety deficiencies will be unavailable.

4.0 *Safety action*

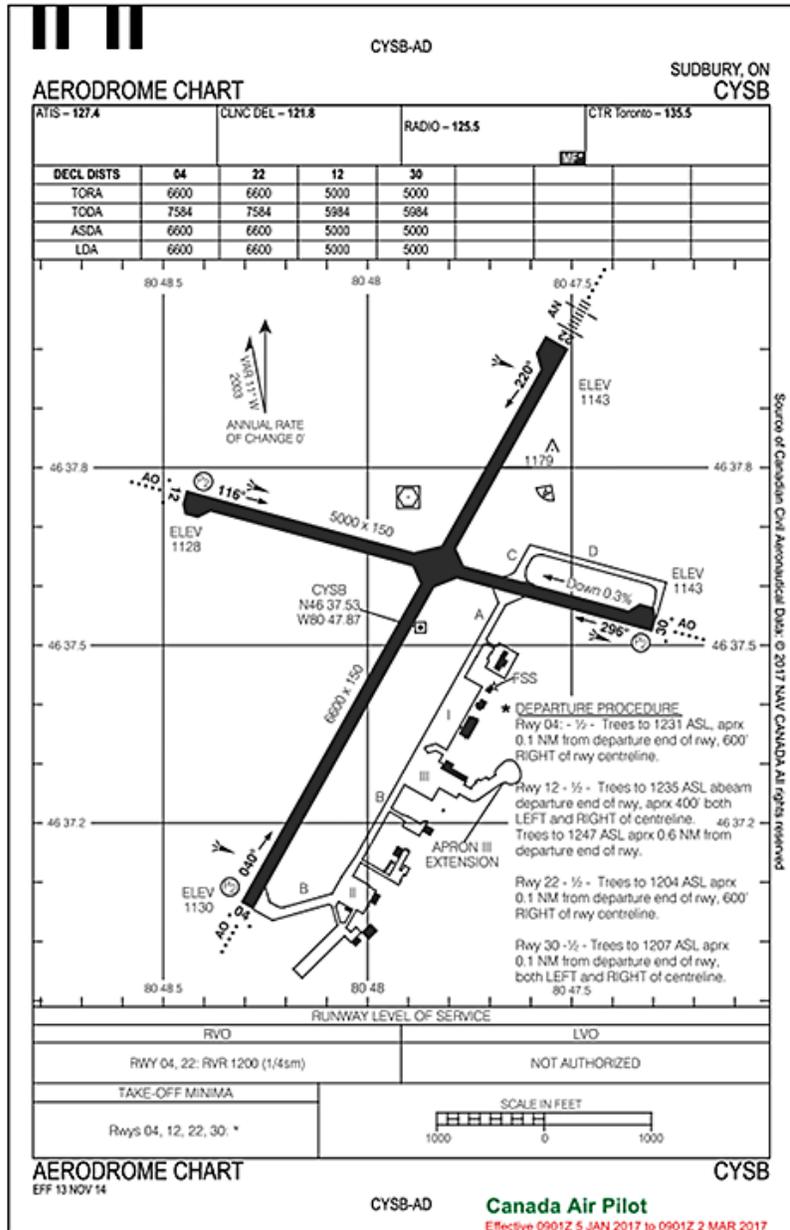
The Board is not aware of any safety action taken following this occurrence.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 17 January 2018. It was officially released on 23 January 2018.

Visit the Transportation Safety Board of Canada'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 key safety issues that need to be addressed to make Canada's transportation system even safer. 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

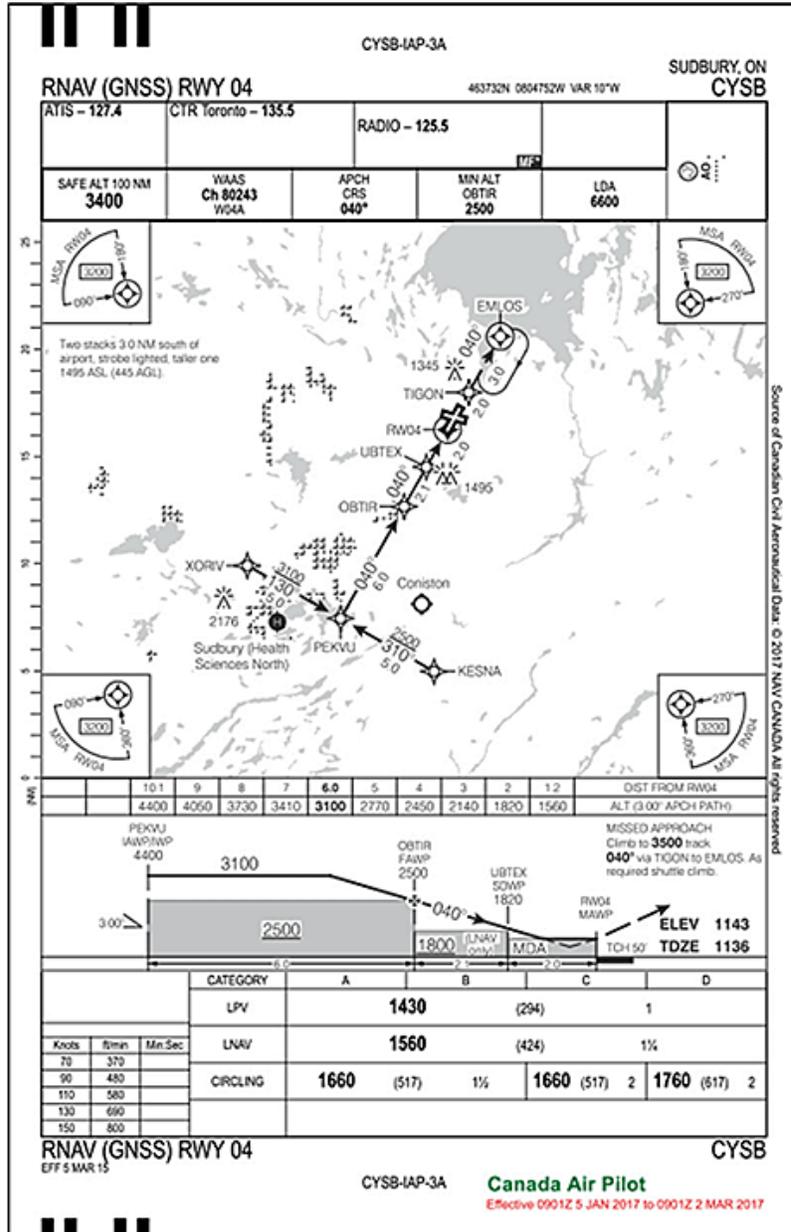
Appendix A – Sudbury Airport aerodrome chart



NOTE: NOT TO BE USED FOR NAVIGATION.

Source: NAV CANADA, *Canada Air Pilot*, effective 05 January 2017 to 02 March 2017

Appendix B – Area navigation approach to Runway 04 at Sudbury Airport



NOTE: NOT TO BE USED FOR NAVIGATION.

Source: NAV CANADA, *Canada Air Pilot*, effective 05 January 2017 to 02 March 2017