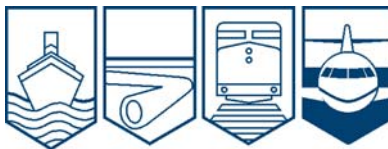


Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

**AVIATION INVESTIGATION REPORT
A10W0038**



LOSS OF SEPARATION

**NAV CANADA
EDMONTON AREA CONTROL CENTRE / YELLOWKNIFE
TOWER
YELLOWKNIFE, NORTHWEST TERRITORIES
01 MARCH 2010**

Canada

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.

Aviation Investigation Report

Loss of Separation

NAV CANADA

Edmonton Area Control Centre/ Yellowknife Tower

Yellowknife, Northwest Territories

01 March 2010

Report Number A10W0038

Summary

The Air Canada Jazz CL600-2B19 was operating as JZA227 from Vancouver, British Columbia, to Yellowknife, Northwest Territories. Approaching 20 nautical miles (nm) south of the Yellowknife Airport, JZA227 was cleared for the straight-in instrument landing system approach for runway 33. Shortly thereafter, the Yellowknife Airport controller advised the Yellowknife sector controller that a Northwestern Air Lease BAE 3112, operating as PLR510, was requesting a departure off of runway 15 for Fort Smith, Northwest Territories. The en route controller approved the departure for PLR510 from runway 15 with a turn after take-off to a heading of 100° Magnetic. At approximately 1800 Mountain Standard Time, a loss of separation occurred when the aircraft passed within 0.8 nm and 500 feet, when 5 nm or 1000 feet was required. The event occurred at dusk.

Ce rapport est également disponible en français.

Other Factual Information

Weather

The weather conditions observed at the Yellowknife Airport at 1800¹ were as follows: winds 110° True (T) at 10 knots, visibility 10 statute miles, ceilings 700 feet above ground level (agl), temperature -1°C, dew point -6°C and altimeter setting 29.78 inches of mercury. The weather was instrument meteorological conditions (IMC) within the Yellowknife Control Zone.

Air Traffic Control Roles and Responsibilities

At the time of the occurrence, an Inter-Unit Arrangement² between the Yellowknife Control Tower and the Edmonton Area Control Centre (ACC) was in effect. This arrangement defines responsibilities of each unit and establishes operating procedures for coordinating the movement of instrument flight rules (IFR) flights between the Edmonton ACC and the Yellowknife Control Tower.

The Edmonton ACC is responsible for all airspace within the Edmonton Flight Information Region (FIR) and that airspace delegated to Edmonton ACC by the Winnipeg ACC, known as the Shield Specialty from FL290 and above³. Within this airspace is the North Low Specialty, which is comprised of seven sectors: Fort McMurray, Inuvik, Peace River, Wolverine, Uranium, Whitehorse/Fort Nelson and Yellowknife. These sectors are responsible for airspace of defined dimensions below FL290. North Low Specialty, a Yellowknife sector, provides control and information services to IFR aircraft, except when the responsibility for control has been transferred to the Yellowknife tower. At the time of the occurrence, the Yellowknife, Whitehorse, Inuvik and Fort Nelson sectors were combined at the Yellowknife sector position. The radar and data positions were also combined.

Yellowknife tower's area of responsibility covers a radius of 5 nautical miles (nm) from the surface to 3700 feet above sea level (asl) around the airport and provides visual flight rules (VFR) control and information services to VFR and IFR aircraft under the tower's control. In IMC conditions, the Yellowknife sector retains control of IFR aircraft. The tower coordinates the selection of operationally suitable departure and arrival runways with the North Low Specialty, a Yellowknife sector.

At the time of the occurrence, the Yellowknife ground and airport positions were combined.

Air Traffic Control Procedures

A portion of the Yellowknife IFR traffic follows a general pattern of arriving from and departing to the south. For convenience, arriving aircraft frequently request the approach to runway 33, despite a performance penalty associated with a tail wind landing. Arrivals to runway 15 or departures from runway 33 are required to backtrack on the southern portion of runway 15/33,

¹ All times are Mountain Standard Time (Coordinated Universal Time minus seven hours).

² Inter-Unit Arrangement between Yellowknife Control Tower and Edmonton Area Control Centre. NAV CANADA. 14 November 2009.

³ FL290 - Flight level 290. An altitude expressed in hundreds of feet, indicated on an altimeter set to 29.92 inches of mercury.

as there is no available taxiway (see Appendix A – Aerodrome Chart of Yellowknife Airport). This results in an increase in the time required to vacate the runway.

Under the Inter-Unit Arrangement, the Yellowknife sector was required to obtain approval from the Yellowknife tower prior to clearing an IFR aircraft for an approach to a runway other than the designated arrival runway. At the time of the occurrence, the designated runways were 15 and 09.

Radar is the primary tool for providing separation between IFR arriving and departing aircraft at Yellowknife. The minimum radar spacing allowed is 5 nm lateral or 1000 feet vertical.

Section 541.2 of NAV CANADA’s Air Traffic Control Manual of Operations (ATC MANOPS) provides radar separation procedures, as follows:

[A controller] may apply separation between an aircraft taking off or executing a missed approach and other radar controlled aircraft provided:

- A. In your judgment, the departing or missed approach aircraft will be radar identified within 1 mile of the end of the runway;
- B. Radar separation will be established at that point;
- C. Continuing separation from all known IFR or CVFR aircraft will be assured.

During IFR operations, the Yellowknife sector controller retains control of IFR aircraft. However, arriving aircraft are required to establish communication with the tower in order to receive landing clearance. As such, the Yellowknife sector controller transfers communications to the tower. Subsequent communications between the Yellowknife sector controller and the IFR aircraft are relayed through the Yellowknife tower controller.

NAV CANADA controllers apply separation between aircraft through consistent reference to, and use of, the following three elements that are fundamental to safe, orderly and expeditious control:

Planning – Determine the appropriate separation required.

Executing – Implement the selected standard.

Monitoring – Ensure that the planned separation is achieved and monitored. ⁴

This is based on a continuous cycle of information acquisition, interpretation and action. As new information is presented to the decision maker, the loop continues through its cycle, resulting in either a confirmation of the original plan’s success or an adaptation to the plan to ensure a satisfactory outcome.

Personnel

The Yellowknife sector controller was licensed, in accordance with existing regulations, and had been a qualified controller for 17 years as well as in the North Low Specialty for 15 years.

The Yellowknife Airport controller was licensed in accordance with existing regulations. The controller had a total of 18 months experience, having received an ATC license for the Yellowknife control tower in June 2008. The controller was a qualified, on-the-job instructor

⁴ ATC MANOPS 301.2. 14 January 2010.

(OJI) and was providing on-the-job instruction to a controller-in-training at the time of the occurrence.

A controller-in-training was also present in the Yellowknife control tower. The controller-in-training had previously undergone training at the Whitehorse tower and transferred to the Yellowknife tower in January 2010. The controller-in-training was conducting the majority of the ground and air communications, under the direct supervision of the Yellowknife Airport controller instructor (OJI).

Sequence of Events

At 1755:46, the Yellowknife sector controller cleared JZA227 for the straight-in instrument landing system (ILS) approach for runway 33 at the Yellowknife Airport. Contrary to the Inter-Unit Arrangement, the Yellowknife sector had not obtained approval from the tower to use runway 33 prior to issuing JZA227's approach clearance. JZA227 was approximately 22 nm from the Yellowknife Airport and 5000 feet above sea level (asl) at this time.

At 1755:57, the Yellowknife Airport controller cleared PLR510 to taxi to runway 15. The Yellowknife Airport controller contacted the Yellowknife sector controller at 1756:06 to advise that PLR510 was taxiing for runway 15 and suggested it be given a turn after takeoff in order to facilitate the departure. The Yellowknife sector controller asked how long it would be before PLR510 would be ready for departure and was advised that PLR510 would be ready in about 1 ½ minutes. The Yellowknife sector controller instructed the Yellowknife Airport controller to amend PLR510's departure to include a turn to 100° Magnetic (M) after takeoff. The Yellowknife sector controller also began to issue a CC⁵, but elected not to include it in the clearance.

At 1756:59, JZA227 was instructed to contact the tower. JZA227 contacted the tower to advise that it was cleared for the straight-in ILS RWY 33 approach (JZA227 was 16 miles from Yellowknife at 5000 asl⁶). The Yellowknife Airport controller provided JZA227 with local weather and information that PLR510 would be departing runway 15 with a left hand turn. The Yellowknife sector controller validated PLR510's clearance via the extended computer display system (EXCDS) and the Yellowknife Airport controller cleared PLR510 for takeoff at 1757:39. There were no restrictions placed on either JZA227 or PLR510 to ensure that the minimum required spacing would be maintained. Ten seconds later, based on the perception that PLR510 was about to roll, the Yellowknife Airport controller advised the Yellowknife sector controller that PLR510 was rolling, although PLR510 remained stationary at the threshold of runway 15.

At 1758:06, the Yellowknife sector controller requested that the Yellowknife Airport controller have PLR510 contact him as soon as it was airborne. The Yellowknife Airport controller acknowledged this request, but did not pass it along to PLR510, as the Yellowknife sector controller issued a second request, at 1758:11, for JZA227 to reduce to minimum approach speed, which was passed on to JZA227. At 1758:39, with JZA227 eight nm from the threshold of runway 33, the Yellowknife Airport controller instructed PLR510 not to delay its takeoff. At

⁵ CC - "Clearance cancelled if not airborne by...". Transport Canada defines CC as "an expression used in radiocommunication to indicate a time specified by an ATC unit at which a clearance ceases to be valid unless the aircraft concerned has already taken action to comply therewith." (<http://www.tc.gc.ca/eng/civilaviation/opssvs/secretariat-terminology-glossary-835.htm>). Website address confirmed accessible as of report release date.

⁶ Altitudes are derived from RADAR sources and may not reflect current altimeter settings in the aircraft.

1758:45, PLR510 reported rolling to the tower. The Yellowknife Airport controller advised the Yellowknife sector controller that PLR510 was airborne at 1759:04; at the time, JZA227 was seven nm from the threshold at 2900 feet asl. Separation between JZA227 and PLR510 was about eight nm and decreasing. In an attempt to provide vertical separation, the Yellowknife sector controller instructed the Yellowknife Airport controller to level JZA227 off at 3000 feet asl and PLR510 at 2000 feet asl. The Yellowknife Airport controller called PLR510, but did not receive a response. At this point, the OJI assumed control of the combined ground and airport control position and communications with all aircraft under the jurisdiction of the Yellowknife control tower.

At 1759:13, the Yellowknife Airport controller contacted JZA227, instructing it to level off at 2500 feet asl, as it had already passed through 3000 feet asl. JZA227 responded that it was currently at 2300 feet asl and asked if it should climb to 2500 feet asl. At this time, separation was approximately 1400 feet vertically and 5.6 nm laterally, and decreasing. The Yellowknife Airport controller confirmed that, if able, JZA227 should return to 2500 feet asl. At 1759:55, PLR510 advised tower that it was in the turn and was told by the tower to level off at its current altitude of 1300 feet asl. JZA227 was at 2300 feet asl and the lateral separation was about 4.7 nm. At 1800:05, PLR510 contacted Yellowknife sector to report it was climbing through 2400 feet asl. At the time, JZA227 was at 2100 feet asl and the lateral spacing was 3.5 nm. At 1800:40, the aircraft were on diverging tracks when the two aircraft passed with 0.8 nm horizontal and 500 feet vertical spacing (see Appendix B – Plan View of Aircraft Convergence). As the conflict developed, no traffic information was passed to either flight.

Due to the requirement to level off during the approach, JZA227 determined that it was not in position to land on runway 33. It announced to the tower that it would be joining for a visual approach for runway 15. JZA227 did not conduct a missed approach, nor was a new approach clearance requested. The airport controller cancelled the landing clearance for runway 33 and re-cleared it for a landing on runway 15. The airport controller then requested transfer of control for JZA227 from Yellowknife sector, which was approved. The weather at the time was IMC; therefore, in accordance with ATC MANOPS and the Inter-Unit Agreement between Yellowknife Control Tower and Edmonton ACC, the airport controller should not have requested or assumed control of JZA227.

JZA227 was able to remain clear of cloud and land on runway 15 without further incident.

Analysis

The focus of this analysis will be on ATC procedures and the decision making process.

The unique layout and traffic patterns at the Yellowknife Airport often results in the use of opposite ends of the runway for departures and arrivals. The ATC MANOPS allows radar and non-radar standards for separating arrival and departures using opposite directions of the same runway. The Yellowknife sector controller attempted to accommodate PLR510 by requesting the departing aircraft to change its heading to 100 degrees. The availability of radar likely made the sector controller believe PLR510 would come into radar contact shortly after takeoff, in accordance with Section 541.2 of ATC MANOPS. The controller may have been successful in executing this plan if the information from the airport controller concerning the readiness of PLR510 had been accurate. The Yellowknife sector controller then attempted to establish vertical separation, which was unsuccessful in achieving the required spacing of 1000 feet.

The fundamental concept of the decision making process of planning, executing and monitoring rests on the decision maker's ability to apply situational feedback into the loop and to reassess the effectiveness of the decisions made.

The initial plan was for JZA227 to conduct a straight-in ILS approach to runway 33. Additional information came into play with the planned and approved departure of PLR510 from runway 15. The Yellowknife sector controller did not modify the plan sufficiently to integrate PLR510 and ensure that the required separation was in place. The Yellowknife sector controller expected that PLR510 would be in the takeoff roll very soon and, therefore, understood that the initial plan remained viable.

Several times during the event, the Yellowknife sector controller issued additional instructions to the Yellowknife Airport controller regarding both JZA227 and PLR510, suggesting that the Yellowknife sector controller was aware that the plan may not be playing out as intended. The Yellowknife sector controller nevertheless continued with the plan because information from the tower suggested PLR510 would soon be airborne. The Yellowknife sector controller had not built in any defences, which would kick-in if the original plan did not work out, such as a CC or a request from PLR510 (through the tower) for an accurate departure time. When PLR510 finally appeared on radar, the Yellowknife sector controller recognized that the initial plan was no longer viable and attempted to issue altitude limits to both aircraft to regain separation. However, this occurred too late.

The Yellowknife tower personnel (trainee and OJI) played a pivotal role in this occurrence. While the Yellowknife sector controller retained control of the arriving aircraft, the Yellowknife Airport controllers had a responsibility to provide the Yellowknife sector controller with accurate and timely information regarding PLR510's takeoff. The Yellowknife Airport controllers were aware of the potential for conflict as they had recommended a heading change for PLR510 after departure. Like the Yellowknife sector controller, the Yellowknife Airport controllers had the expectation that PLR510 was going to initiate a takeoff once the clearance was given. One minute and twenty-five seconds had elapsed from the time the takeoff clearance to PLR510 was issued and the aircraft actually took off. No action was taken at that point to ensure minimum spacing. Given that the Yellowknife sector controller's plan was predicated on a reasonably quick takeoff and the assurances from the tower that the aircraft would depart soon, the delay contributed to the eventual loss of separation.

The relay of information between the sector and airport controllers and the aircraft took time, which delayed the issuance of restrictions to JZA227 to level off at 3000 feet and PLR510 at 2000 feet. JZA227 was already through 3000 feet. Notwithstanding the lack of authority to do so, the Yellowknife Airport controller (OJI) issued new altitudes to both JZA227 and PLR510 in an attempt to provide some form of vertical separation. The Yellowknife sector controller was not informed by the Yellowknife Airport controller that the requested altitude restrictions were not in place. The two aircraft passed with 0.8 nm lateral and 500 feet vertical spacing. There was a risk of collision during the time the two aircraft were on converging tracks without any altitude restrictions.

JZA227 manoeuvred for a visual approach for runway 15, under IMC, when a missed approach or subsequent IFR clearance was required. The sector and airport controllers lost situational awareness when transfer of control of JZA227 was requested and given to allow the aircraft to complete a visual approach to runway 15.

Findings as to Causes and Contributing Factors

1. The Yellowknife sector controller did not effectively coordinate with the Yellowknife Airport controller for the instrument arrival of JZA227 onto the non-designated runway at the Yellowknife Airport, and did not issue a clearance cancelled time for the departing aircraft.
2. The Yellowknife Airport controller communicated with the Yellowknife sector controller that PLR510 was taking off, when in fact the aircraft was still at the threshold of runway 15 and, therefore, the Yellowknife sector controller's mental model was compromised.
3. When the conflict was recognized, the Yellowknife sector controller attempted to provide vertical separation; however, the radio relay of the instructions through the Yellowknife Airport controller resulted in sufficient delays that separation between the aircraft was lost.

Other Findings

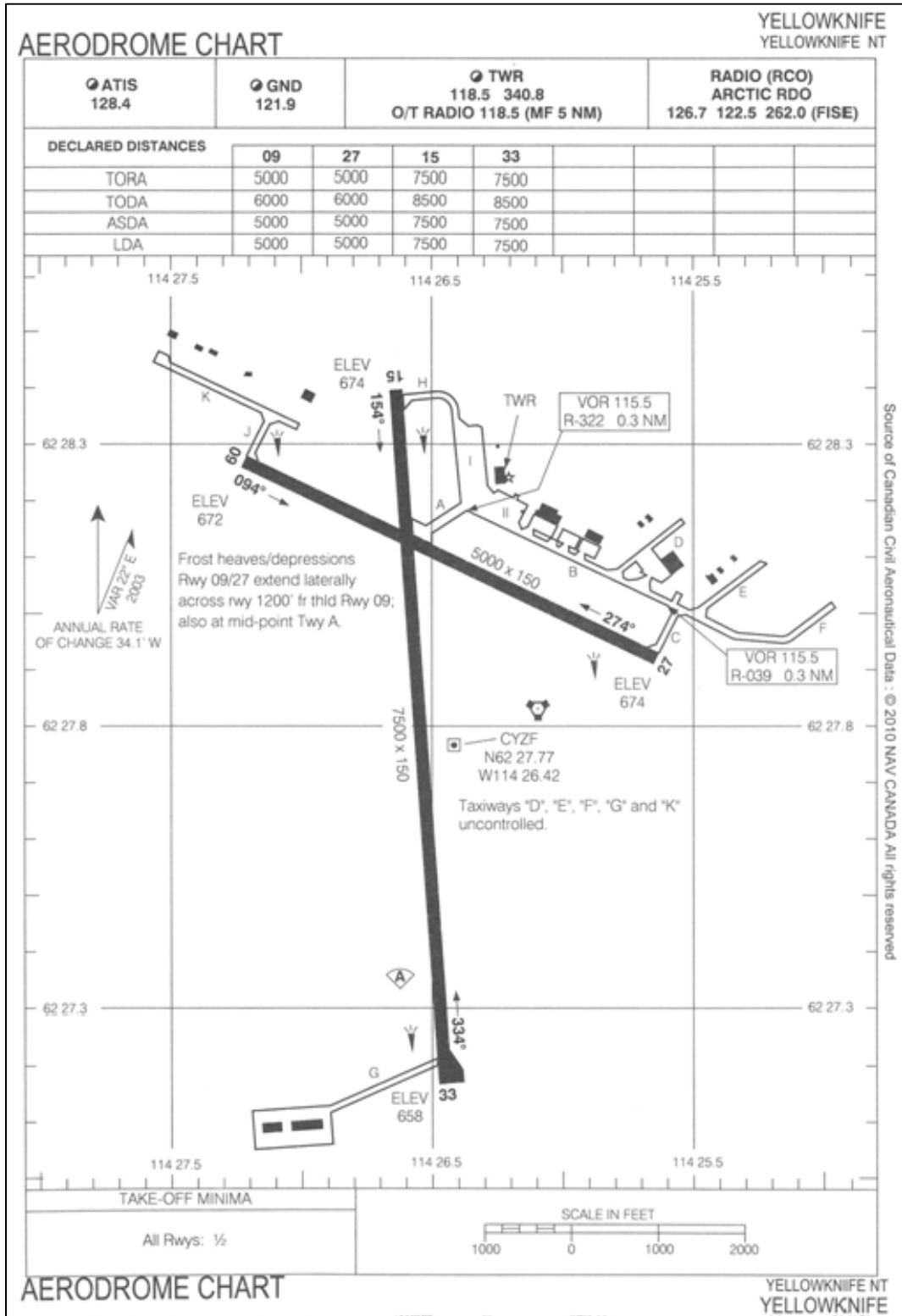
1. JZA227 manoeuvred for a visual approach for runway 15, under instrument meteorological conditions (IMC), when a missed approach and re-clearance was required.
2. The Yellowknife Airport controller requested and the Yellowknife sector controller approved the transfer of control of JZA227 during the visual manoeuvre to runway 15 when IMC existed.

Safety Action Taken

The Yellowknife Control Tower has issued a unit operations bulletin and briefed controller staff on the plan, execute and monitor process. The bulletin emphasized the timely and accurate transfer of information to participating agencies. Additionally, it emphasized that the role Yellowknife Airport controllers play in the execution of a plan is an active one, and that they are instrumental in ensuring the safe and efficient control of traffic.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 12 November 2010.

Appendix A – Aerodrome Chart of Yellowknife Airport



Not for navigation purposes

Appendix B – Plan View of Aircraft Convergence

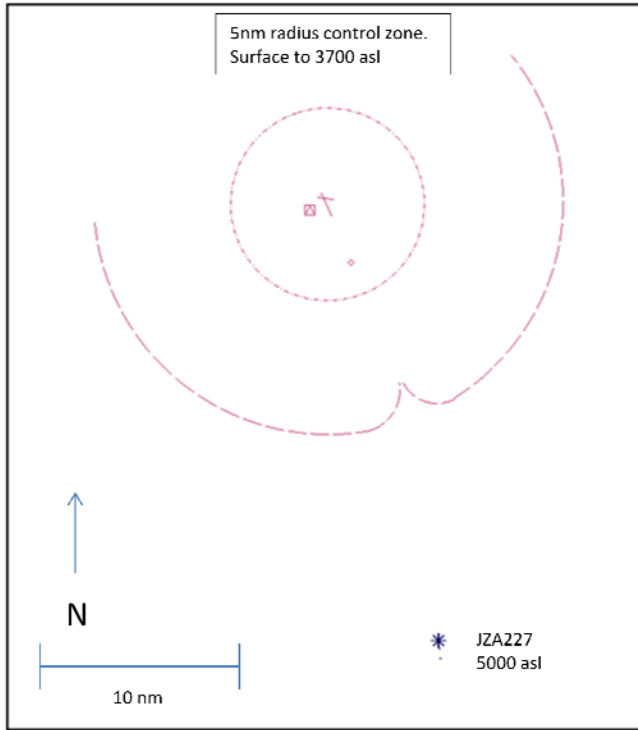


Figure 1. JZA227 cleared ILS Rwy 33 at 1755:46.

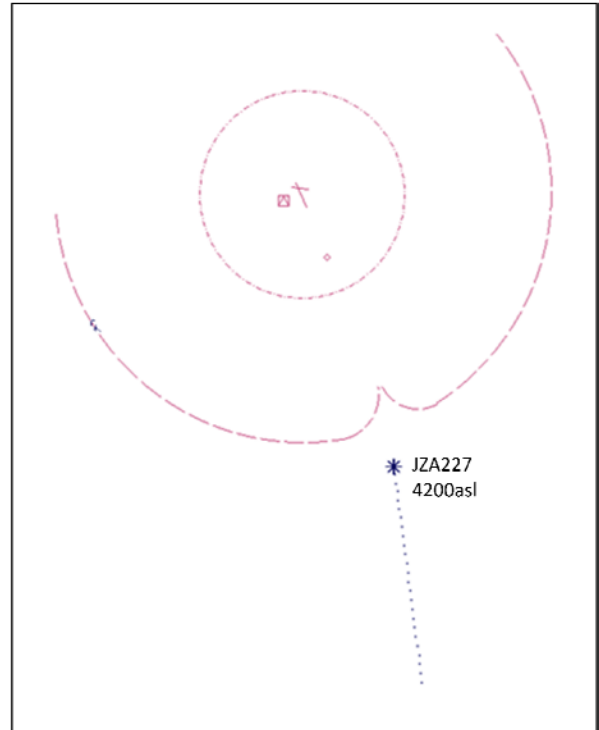


Figure 2. JZA227 position when PLR510 cleared takeoff Rwy 15 at 1757:39.

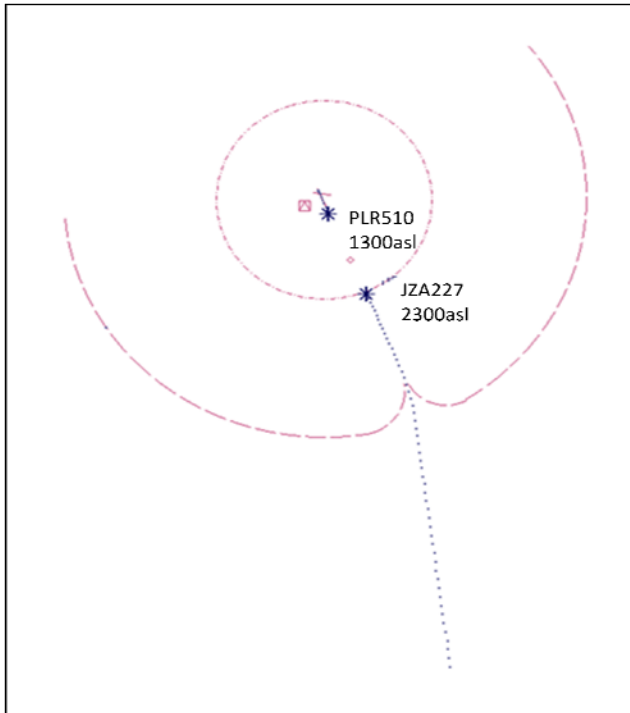


Figure 3. PLR510 calls Yellowknife tower in the turn at 1759:55. Aircraft are separated 4 nm horizontally and 1000 feet vertically.

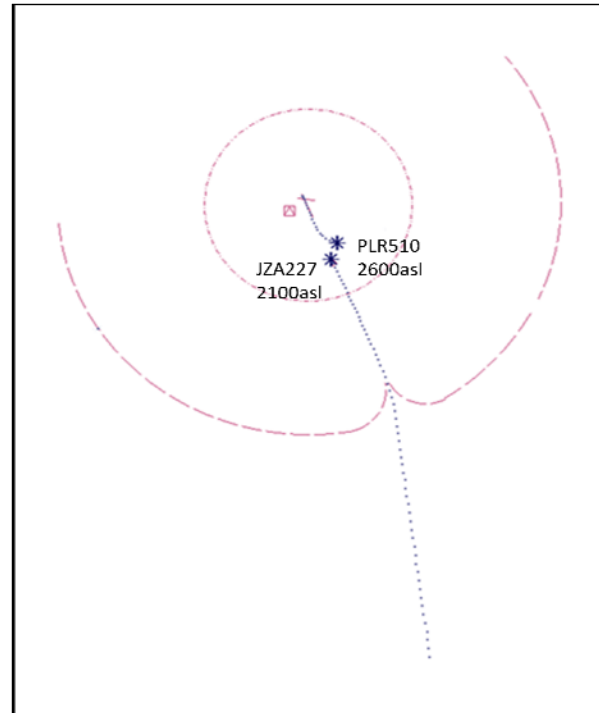


Figure 4. PLR510 and JZA227 at lowest separation of 0.8 nm and 500 feet (1800:40).