

Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A01Q0053



LOSS OF SEPARATION

NAV CANADA
MONTRÉAL AREA CONTROL CENTRE
MASSENA, NEW YORK
27 MARCH 2001

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

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Summary

A Royal Airlines Airbus A310, Flight 4522, registration C-GRYV, took off from Runway 32 at the Ottawa / Macdonald-Cartier International Airport en route to John F. Kennedy International Airport in New York City. About one minute later, an Air Canada Bombardier Regional Jet (RJ), Flight 662, registration C-FZAQ, took off from Runway 25 at the Ottawa International Airport, en route to Boston, Massachusetts. Both were cleared to maintain 15 000 feet and were then handed off to the Valley sector of the Montréal Area Control Centre. At that time the Airbus was about 10 nautical miles (nm) north of, and slightly behind, the RJ and was on a heading of 140°. The RJ was on a heading of about 130° proceeding directly to the Massena VOR (VHF omnidirectional radio range). Both aircraft were cleared to maintain flight level 190 (FL190) and then FL220. A loss of separation occurred when the aircraft closed to 3.7 nm with less than 1000 feet of vertical separation. Subsequently, the Airbus, at FL230, conflicted with C-GLEM, a Piaggio P-180 at FL230 inbound to St. Hubert, Quebec. These aircraft approached to 3 nm. The minimum separation required in both instances was 5 nm lateral or 1000 feet vertical spacing.

Ce rapport est également disponible en français.

Other Factual Information

The air traffic controller at the time of the first incident was a trainee under the supervision of an on-job instructor (OJI). The Valley sector trainee controller had three years' experience as a controller and had been under training in the Valley sector of the west specialty subunit of the Montréal Area Control Centre (ACC) for five months. The OJI was controlling at the time of the second incident. The Valley sector OJI had nine years' experience as a controller and seven years' experience in the west specialty. Both controllers were working the fifth day of their shift cycle. They had been on duty for approximately two hours on the day of the occurrence and for approximately 30 minutes since the last relief break. Workload was described as moderate.

The Airbus took off at 1631¹ and was given a right turn to a heading of 140°. At 1637:05, the Airbus captain contacted the Valley controller and advised that they were climbing through 11 600 feet on their way to 15 000 feet and were on the assigned heading of 140°. The Regional Jet (RJ) took off at 1632 and was given a left turn to a heading of 140° until able to proceed direct to the Massena VOR (VHF omnidirectional radio range). At 1636:50, when about 14 nautical miles (nm) south of Ottawa, the RJ crew contacted the Valley controller advising that they were through 12 400 feet climbing to 15 000 feet and were proceeding direct to the Massena VOR.

After passing the Massena VOR, the RJ's route was to take it southeasterly toward a VOR north of Boston; the route of the Airbus after Massena was to continue southbound to John F. Kennedy International Airport. The controller's aim was to enable the aircraft to cross tracks with appropriate vertical separation as they approached the Massena VOR before exiting Canadian airspace. The Valley controller monitored the climb and issued matching climb limits to flight level (FL) 190 and later to FL220 for both aircraft as they approached the Massena VOR.

Shortly after the Valley controller cleared the Airbus to FL220, the OJI, having recognized the converging flight paths of the aircraft, advised the Valley controller that the control strategy being implemented was not going to work. The aircraft were 7 nm apart and converging at an angle of approximately 10°. The Valley controller then directed the Airbus to maintain FL200 and, "for the climb", to turn left "three zero degrees".

The Nav Canada *Air Traffic Control Manual of Operations* (ATC MANOPS), article 507, directs controllers to "issue a safety alert to an aircraft if you are aware the aircraft is at an altitude which, in your judgement, places it in unsafe proximity to the terrain, an obstruction or another aircraft." The recommended phraseology to alert a pilot to conflicting traffic is as follows:

TRAFFIC ALERT (position of traffic, if time permits), ADVISE YOU TURN
RIGHT/LEFT (specific heading, if appropriate), or CLIMB/DESCEND
(specific altitude, if appropriate) IMMEDIATELY.

The Valley controller did not issue a safety alert using the phraseology recommended in ATC MANOPS.

¹ All times are eastern standard time (Coordinated Universal Time minus five hours).

ATC MANOPS, Part 9, provides direction to controllers on the methods of recording aircraft altitudes on flight progress strips. When the Valley controller cleared the Airbus from FL220 to FL200, the new flight level was not entered on the flight progress strip for the Airbus; however, the flight progress strip for the RJ shows 200 in the altitude box. A clearance of FL200 was not issued to the RJ throughout the radio exchanges, though the OJI advised the crew to stop the climb when at approximately FL202.

ATC MANOPS, article 543.1, specifies three methods by which a controller may issue radar vectors to aircraft. The choices include specifying the heading to be flown, specifying the direction of the turn and the heading to be flown after the completion of the turn, or specifying the direction and the number of degrees to turn. The Valley controller specified the direction and the number of degrees to turn.

The standard division of work between the captain and the first officer of the Airbus required that, when above 10 000 feet on departure, the pilot not flying would transmit the departure message on the company frequency. When the Valley controller instructed the Airbus to maintain FL200 and "for the climb" to turn left "three zero degrees", the first officer was in contact with the company, and the captain was flying the aircraft with the autopilot. The captain was monitoring the company frequency and the air traffic control frequency.

The captain misheard the clearance from the Valley controller and requested confirmation that the clearance was to climb to FL300. As well, he repeated what he thought was the instruction to turn right to a heading of 170° (30° right). The Airbus began a right turn but then reversed when the Valley controller repeated the instruction to turn left 30°. By the time the captain was able to reverse the turn, the aircraft had turned through approximately 20° and closed to 3.7 nm from the RJ. At the time, the aircraft were separated vertically by approximately 800 feet (Appendix A, Figure 1).

The captain of the Airbus reported seeing the symbol for the RJ on the cockpit traffic alert and collision-avoidance system (TCAS) display. However, the relative geometry of the two aircraft did not meet the requirements for the generation of a traffic alert or a resolution advisory.

After a repeat request by the Airbus pilot to confirm that the clearance was to climb to FL300, the Valley controller transmitted a message using the prefix for the RJ, Air Canada, but the flight number for the Airbus, with the message to maintain FL220 and to turn left now. Neither aircraft responded to the transmission.

After the Valley controller's transmission using the prefix of the RJ and the flight number of the Airbus, the OJI took control of the radio and directed the RJ to stop the climb immediately and to turn right 30°. The RJ crew acknowledged. The OJI then cleared the Airbus to continue climbing to FL230. The Airbus acknowledged and advised in the left turn to a heading of 110° (as previously instructed by the trainee).

This investigation, and others, have found that OJIs are hesitant to intervene too soon to rectify trainee hesitations or errors, believing that trainees, to learn, must be permitted to make their own decisions. OJIs have expressed the sentiment that early intervention will demoralize the trainee and reduce training effectiveness.

At 1641:25, as the aircraft were approaching the airspace boundary between Montréal ACC and Boston Air Route Traffic Control Center (ARTCC), the OJI initiated handoff communications with the Boston ARTCC controller. After completing the exchange and issuing a clearance to the RJ at 1641:55, he noticed the approaching conflict between the Airbus and a Piaggio P-180. The Airbus was at FL230 on a heading of approximately 115°. The Piaggio P-180 was also at FL230 over the Massena VOR approximately 4 nm south of (to the right of) the Airbus. The OJI issued an instruction to the Airbus to turn right immediately to a heading of 080°. Without waiting for a reply, the OJI then issued an instruction to the Piaggio P-180 to turn right to a heading of 150° immediately. This instruction was followed by a third transmission from the OJI, the first part of which was to the Piaggio P-180 repeating the instruction to turn right to a heading of 150° and continuing without interruption to the Airbus to turn left to a heading of 060°. The crew of the Airbus stayed on their heading of 110°, and the Piaggio P-180 crew turned right. The two aircraft approached to within 3 nm while at the same flight level (Appendix A, Figure 2). The OJI did not issue a safety alert using the phraseology recommended in ATC MANOPS.

The pilot of the Airbus did not see the Piaggio P-180 or notice the aircraft's intruder symbol on the cockpit TCAS display, and the relative geometry of the two aircraft did not meet the requirements for the generation of a traffic alert or a resolution advisory. The pilot of the Piaggio P-180, after receiving further instructions from the OJI to descend, reported that the Airbus was in sight.

In 1997, the TSB issued Aviation Safety Advisory A970038 to Nav Canada on the topic of safety alert phraseology. In December 1999, the TSB again raised the issue of safety alert phraseology in Aviation Safety Advisory A990050-1. In response to Aviation Safety Advisory A970038, Nav Canada assured the TSB that the issue would be given wide circulation within the company and that the topic would be treated as a priority topic during the 1998 refresher training program. Nevertheless, the TSB's investigations into losses of separation indicate that controllers continue to be resistant to using the required phraseology to deal with safety-critical situations.

In Aviation Safety Advisory A990050-1, the TSB noted that current and proposed defences against the threat of midair collision are not adequate and that there are undefended risks associated with controllers not being adequately prepared to reduce the potential for a midair collision once a loss of separation has occurred. The TSB suggested that Nav Canada may wish to consider taking action to better prepare controllers to reduce this potential.

In September 2000, the TSB recommended (Recommendation A00-15) that Nav Canada commit, with a set date, to the installation and operation of an automated conflict prediction and alerting system at the nation's air traffic control facilities to reduce the risk of midair collisions. Nav Canada has implemented conflict-alert functionality in the Moncton ACC high-level sectors, and site trials are scheduled for some other ACCs during 2002.

Analysis

The controllers recognized the first developing loss-of-separation situation and issued instructions that, if followed, would likely have prevented it. However, the phrasing of the corrective action did not convey that it was a safety-critical message and that its purpose was to

direct the Airbus away from conflicting traffic on the right. The last minute intervention left insufficient time for the controller or the OJI to react before the misinterpreted message caused the loss of separation. Safety alert phraseology is intended to attract the immediate attention of the flight crew to focus their attention on the content of the message. The same lack of safety alert phraseology occurred during the second loss of separation between the Airbus and the Piaggio P-180.

Errors by trainees are likely. For this reason, a trainee is generally under the guidance of an experienced tutor and does not operate under his or her own licence. However, the OJI cannot quickly intervene with flight crews to correct errors because the intervention is often done through the trainee who committed the original error. Under normal circumstances, miscommunication regarding the direction of a turn, together with permissive OJI monitoring, would not have led to an adverse result. However, this and other occurrences indicate that when trainees aim for the minimum permitted level of separation, unforeseen interruptions or pilot misunderstandings and the delays that are inherent in second-hand controlling can lead to losses of separation.

The avoidance vector issued by the Valley controller included the direction to turn left and the number of degrees to turn. The captain of the Airbus mis-heard the left-turn instruction but did hear the reference to 30° and initiated a right turn to a heading of 170° before being corrected by the controller. A right turn would fit his expectation to overfly Massena en route to John F. Kennedy International Airport, because, from his position at the time, a right turn would have been necessary to accomplish that. Using the vectoring technique of direction of turn and the number of degrees to turn provides one piece of information as to the final result of the vector. Using the direction of turn and the final heading provides two clues as to which direction to go. The vector "Turn left heading 110" is explicit as to both the direction of turn and its final disposition.

The Airbus captain, having already been cleared to FL220 would not have anticipated a clearance to a lower flight level, especially when that clearance was accompanied by the terminology "for the climb". The use of this confusing terminology and the subsequent pilot efforts to confirm the meaning of the transmission delayed the resolution of the first loss of separation.

After both losses of separation, both controllers issued conflicting and erroneous directions in their transmissions. In the first situation, the trainee issued an instruction using the Air Canada company name and the Royal Airlines flight number. In the second situation, the OJI issued the Airbus a turn that would have taken that aircraft closer to the Piaggio P-180. Techniques for resolving losses of separation in time-critical situations should be an important element of a controller's training.

Findings as to Causes and Contributing Factors

1. The Valley controller and the on-the-job instructor (OJI) did not issue timely avoidance instructions to ensure the required separation between the Regional Jet and the Airbus.

2. The OJI did not monitor the traffic in sufficient detail to be aware of the flight level of the Piaggio P-180. As a result, the Airbus was cleared to that same flight level.

Findings as to Risk

1. When giving instructions to the Airbus crew to prevent a loss of separation, the Valley controller used phraseology that was somewhat ambiguous and that failed to convey a sense of urgency to the crew.
2. The OJI did not use the recommended safety alert phraseology to warn the Airbus and the Piaggio P-180 crews of the nearby conflicting traffic. The transmissions were incorrect, rushed, and confusing.
3. The OJI tacitly permitted the trainee Valley controller to delay issuing resolution instructions to conflicting traffic. A pilot's error in interpreting the avoidance action then resulted in the loss of separation. The controllers did not consider that the flight crew might make an error or unexpectedly delay action.
4. Nav Canada does not provide sufficient training to controllers in time-critical conflict resolution.
5. Nav Canada radar systems in Montréal Area Control Centre are not equipped with automatic defences to alert controllers to impending aircraft conflicts.
6. The crew of the Airbus turned right when a left turn had been directed. This error increased the rate of closure between the Airbus and the Regional Jet.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 11 June 2002.

Appendix A: Airspace Diagrams

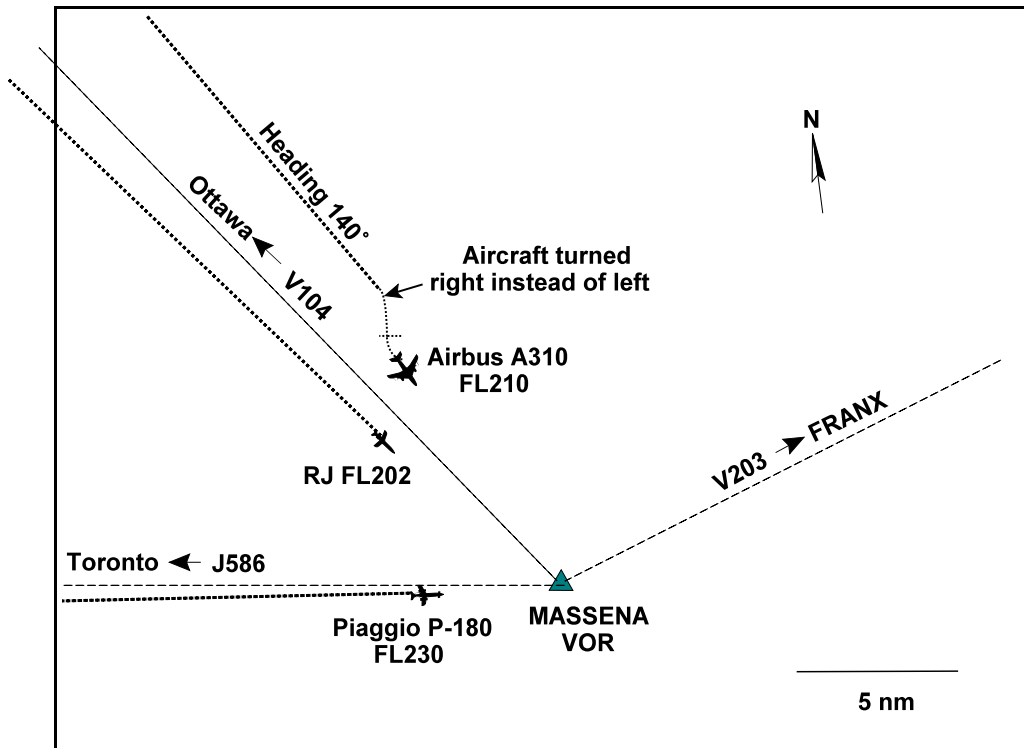


Figure 1. Loss of separation between the Airbus and the Regional Jet.

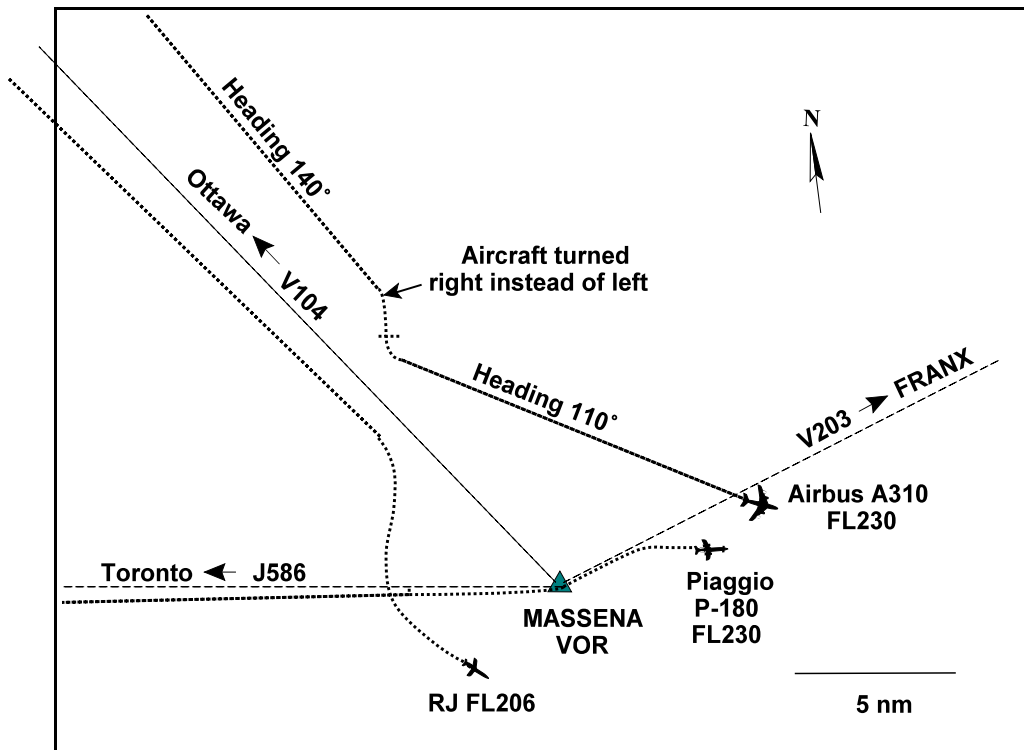


Figure 2. Loss of separation between the Airbus and the Piaggio.