

AVIATION OCCURRENCE REPORT

LOSS OF SEPARATION BETWEEN

AIR CANADA BOEING 767 C-GAUB (ACA109) AND

MORNINGSTAR AIR EXPRESS INC.

CESSNA 208 CARAVAN C-FEXX (MAL7072)

VANCOUVER, BRITISH COLUMBIA

30 MAY 1997

REPORT NUMBER A97P0153

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

At about 1454 Pacific daylight time (PDT), the Vancouver ATC Arrival controller cleared ACA109, an Air Canada Boeing 767, for an instrument landing system (ILS) approach to runway 08 Left at Vancouver International airport. This clearance was accepted and read-back in error by ACA897, an Air Canada Boeing 747, but neither the controller nor the crew of ACA109 detected the incorrect aircraft identification. The ACA109 continued on its last assigned vector and flew through the localizers for runways 08 Left and Right at 3,000 feet, on a course toward a Morningstar Cessna 208, inbound to the airport at 3,000 feet. The controller identified the potential conflict and issued avoidance vectors to both aircraft; this action, however, did not prevent the loss of separation between them. The aircraft spacing had been unintentionally reduced to 2.11 nautical miles (nm) at the same altitude, with the aircraft on diverging headings, in an area where either 3 nm lateral or 1,000 feet vertical separation was required. Although there was a loss of separation, there was no risk of collision. The controller then re-sequenced the aircraft for landing at Vancouver without further event.

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All times are PDT (Coordinated Universal Time minus seven hours) unless otherwise noted.

Other Factual Information

In the five minutes leading up to the loss of separation, the Boeing 767 (ACA109) was north-east of Vancouver, inbound from Toronto, and was carrying out the BOOTH FOUR standard terminal arrival procedure (STAR) leading to an ILS approach to runway 08 Left (L). At the same time, the Boeing 747 (ACA897) was north of Vancouver, inbound from London, U.K., also for runway 08L. The Cessna 208 (MAL7072) was to the south on the V338 airway, arriving from Victoria, heading for runway 08 Right (R).

Air traffic control (ATC) communication tapes and radar data show that at 1453:14, the ATC arrival controller cleared ACA109 to turn left to a heading of 170° and to maintain 2,000 feet; the pilot acknowledged that instruction, and the aircraft then turned left to 170° and continued descent, at this time through 5,300 feet. The clearance to 2,000 feet was to provide the required vertical separation of 1,000 feet with MAL7072, and the controller had predicated his traffic control sequencing based on ACA109 descending to 2,000 feet. ACA109 levelled off at 3,000 feet, however, and when the controller saw that the ACA109 had not yet reached the assigned altitude, he instructed MAL7072 to turn 10° left to provide more lateral spacing.

When the pilot of ACA897 checked-in on the inner arrival frequency, the arrival controller purposely did not immediately acknowledge, instead the controller focussed on giving ACA109 an approach clearance, since it was a higher ATC priority. Accordingly, he instructed ACA109 to turn to a heading of 110° to intercept the localizer, and cleared it to conduct the ILS approach to runway 08L. Noticed by neither the controller nor the ACA109 crew, this clearance was read-back in error by ACA897. At that time, ACA897 was about 18 nm north of Vancouver, in a descent through 6,000 feet to 4,000 feet. The aircraft was over an area of high terrain where the minimum vectoring altitude (MVA) was 3,700 feet. ATC is not authorized to clear aircraft to fly below the MVA; furthermore, considering the number of aircraft in the area and the potential for conflict, ATC would likely not issue an approach clearance to an aircraft in this location.

The captain of ACA897 did not question the ATC clearance he believed was for his aircraft. After accepting this clearance, the pilot of ACA897 began a left turn and continued descending. About 5 seconds later, the controller instructed ACA897 to turn 10° right and to maintain 4,000 feet. The pilot of ACA897 asked for confirmation of these instructions, and the controller instructed the aircraft to turn right to a heading of 190° and to maintain 4,000 feet. ACA897 acknowledged this clearance, and without further comment about the approach clearance received and acknowledged just a few seconds earlier, the pilot turned back to a heading of 190°, and continued to descend to 4,000 feet; the aircraft did not descend below MVA.

The pilots of ACA109 heard the pilot of ACA897 accepting an approach clearance for the ILS to runway 08L, and although they were in a location on the arrival path where they were expecting an approach clearance, they assumed that the clearance was intended for ACA897 – even though their own call-sign was used – because ACA897 had accepted it so quickly and because the controller had acknowledged the read-back.

At 1454:48, the controller observed that ACA109 was about to fly through the localizer for runway 08L at 3,000 feet and 90° to the localizer, and he asked the pilot if he was going to intercept the localizer. The pilot

replied that they did not know they had been cleared to intercept the localizer. On some occasions in the past at other Canadian airports, the captain of ACA109 had been given radar vectors which had flown him through the localizer to provide increased aircraft spacing on the final approach. In this incident, he reasoned that the delay in the approach clearance may also have been deliberate. As well, in the 30 seconds between ACA897 accepting the wrong clearance and the controller asking ACA109 his intentions, the first 25 seconds was continuous communication between the controller and other aircraft; the pilot of ACA109 was reluctant to request further clearance because he did not want to risk transmitting over any instructions from ATC. For the captain of ACA109, not receiving the anticipated approach clearance during the only 5-second period of free radio space would have been the only clue he would have had that his aircraft had been missed in the ATC approach sequence, and he then had insufficient time to prevent crossing the localizers.

Based on the projected flight path of ACA109 which had now crossed both localizers at 3,000 feet, the controller immediately instructed MAL7072 to quickly turn right to a heading of 060° to maintain lateral separation. At 1455:00, the controller instructed ACA109 to "...maintain 2,000, expedite descent", and to turn right to a heading of 230°. The pilot acknowledged these instructions; however, the captain had already begun a firm, left turn back to the airport, and the aircraft was now headed directly toward MAL7072. The captain had been anticipating a left turn, and he thought the controller had instructed him to turn to a heading of 230°, a heading which was consistent with his expectations. The first officer then asked for confirmation of the heading, and when the controller repeated the 230° heading, the captain began a turn to the right. The aircraft continued at 3,000 feet.



At 1455:34, the controller again instructed ACA109 to descend, using the phrase "...descend to 2,000 now"; 26 seconds later, the aircraft began to descend from 3,000 feet. In the meantime, the delay caused by this additional communication exacerbated the collision course geometry with MAL7072, and the arrival controller turned MAL7072 to a heading of 120°; this action, however, did not prevent the loss of separation between ACA109 and MAL7072.

During this latter period, the captain of ACA109 had disconnected the autopilot and was hand-flying the aircraft because the electronic flight control systems would not have permitted a sharp intercept turn back to the localizer. He was also initially unaware of the urgency of the situation until the controller instructed them to descend to 2,000 feet "...now." Conventional caution requires that, when the Boeing 767 is being flown in the hand-flying mode, pilots refine their control inputs to avoid sharp aircraft response and passenger discomfort. This flying technique, however, can result in slower aircraft response to pilot commands, and could introduce an element of delay to some ATC instructions.

At the time of this incident, the arrival controller was working both arrival positions, arrival high and arrival low. The complexity of the terminal operations was light to moderate, and the controller was actively controlling eight aircraft. This position combination was a routine arrangement in the Vancouver Area Control Centre, and was the result of both personnel shortages in the terminal specialty and reduced air traffic volume traditionally experienced at that time of the day. In this incident, the positions had been combined because of the low traffic volume. Efforts had been underway by Nav Canada to resolve this personnel shortage, and as an interim measure, staff shortfalls were compensated for by combining controller positions, by increasing overtime requirements, and by restricting traffic flow both into and out of the airport.

To maintain safe and responsive air traffic flow, pilots are required to comply with ATC clearances accepted by them, and with ATC instructions directed to and acknowledged by them, subject to their final responsibility for the safety of their own aircraft. In part, MANOPS 133.4 requires ATC controllers to obtain an accurate readback when issuing or relaying an amendment to an IFR clearance or instruction. In sections 201.5 and 201.6, controllers are required to ensure that the readback of a message is correct, and to identify and correct any errors.

To ensure effective, consistent, and correct communication between ATC and aircraft, the Transport Canada document entitled the "Aeronautical Information Publication" (AIP) contains, in part, examples of radio telephony phrases, and, specifically in section COM 5-7, pilots are instructed to acknowledge all messages directed to them. In this incident, the acknowledgements should have, and did, take the form of a repeat of the clearance with the aircraft call-sign. International protocols regarding the position of the aircraft call-sign in radio messages have been developed over the years, and it is now a standard practice for pilots to place the aircraft call-sign at the end of their message when reading back a clearance. In this incident, that convention was also followed.

To provide communication precision and consistency, article 507.1 in MANOPS, details the safety-alert phraseology to be used when a controller becomes aware that an aircraft is at an altitude which places it in unsafe proximity to another aircraft. That phraseology uses compelling language to elicit a prompt response from the pilot, and would be made, for

example, as follows: “(Call sign)...Traffic Alert...Climb to (altitude) feet immediately.” In this incident, although the controller did not use the safety-alert terminology outlined in MANOPS, he did use language which identified a sense of priority when he said “...expedite...” and “...now.”

A key factor in communications between pilots and controllers is “readback/hearback”, which is the process of mutual verification of information passed between them. The pilot’s readback of ATC instructions serves as a double-check to catch communication errors; hearback is the process where the controller actively monitors the pilot’s readback for deviation from the original instruction. Research has shown that when it comes to listening, humans hear what they are expecting to hear, hear what they want to hear, and frequently do not hear what they do not anticipate hearing. Speech communication is influenced by a set of expectations that exists merely by knowing what activity is being performed. In any given situation, humans recall the educated expectation they think is most appropriate for the particular activity. It is this expectation that helps a person understand the message; if the message is inappropriate or totally unexpected, the expectation may hinder the understanding of the message. The phenomenon of expectation is particularly common and hazardous in the readback/hearback process, especially if non-standard phraseology is used.

In the context of air traffic control, pilots frequently read back and act upon clearances that they were expecting to receive, and not the actual clearance parameters given them by the controller. Often, a controller does not detect the erroneous readback from the pilot because his attention had been diverted to resolving a concurrent air traffic control issue. In the North American ATC environment, readback/hearback errors such as these occur constantly, and result in operating irregularities such as deviation from assigned altitudes, and turns to incorrect vector headings.

In the aviation system, communication has come to serve a central role in the creation and maintenance of proper situational awareness. The likelihood of successful communications depends on several factors, such as the level of attention of the recipient, the level of comprehension of the recipient, the level of acceptance of the message, and the effectiveness of the feedback from the recipient to the communicator.

Analysis

The circumstances of this incident led the investigation to focus on the readback/hearback process, and the operational reasons surrounding the actions of the flight crews and controller involved. The pilot-controller communication errors made in the readback/hearback process led to the flight crew of one aircraft continuing descent to an altitude that could have been unsafe, and led to the flight crew of a second aircraft flying through the approach paths for two runways at a busy, international airport, lose separation with yet a third aircraft, and to conflict with several other aircraft in the vicinity.

The chain of events starting at 1453:14 that led to this incident was circumstantial and comprised many elements; the most notable are summarized in the following items:

- although instructed to maintain 2,000 feet, ACA109 remained at 3,000 feet;
- the controller focussed on turning ACA109 onto final for runway 08L and he did not immediately respond to the ACA897 initial check-in transmission;
- ACA109 did not hear the approach clearance intended for them;
- ACA897 intercepted the approach clearance intended for ACA109;
- the controller did not detect the incorrect call-sign during the readback from ACA897;
- ACA109 assumed the clearance was for ACA897;
- ACA897 did not challenge a rapid and significant revision to an approach clearance;
- ACA109 did not seek further clearance as it approached the localizer;
- the captain of ACA109 misheard the controller's heading instruction;
- ACA109 turned left after crossing the localizers without ATC instruction; and
- ACA109 did not descend in a timely manner.

Despite the call-sign for ACA109 being clearly at the beginning of the controller's communication, the crew of ACA897 had assumed that the approach clearance (intended for ACA109) was directed to them because the controller's response immediately followed their initial-contact radio transmission. However, these instructions from the controller, which included a final approach clearance, when the aircraft was still 18 nm away from the airport, would have been atypical in these circumstances, and should have alerted these pilots to an abnormal situation or development; similarly, the lack of an altitude restriction would have been irregular considering that the floor for radar vectoring was 3,700 feet in that area. It was not determined why the pilots of ACA897 believed that such an approach clearance would have been appropriate for their aircraft and circumstances. Nevertheless, they accepted and began to follow a clearance that would have placed the aircraft below MVA. It was also not determined why they did not subsequently question the significant and rapid change to their approach clearance.

It could not be determined why the pilots of ACA109 did not identify the approach clearance from the arrival controller as being theirs, even though this clearance was issued when their aircraft was at a location where they were, and should have been, expecting such a clearance. They heard the pilot of ACA897 accepting an approach clearance, and assumed that the clearance was indeed intended for ACA897, because ACA897 had accepted it so quickly and because the controller had acknowledged the read-back.

At 1453:14, before ACA109 had turned toward the localizer, the controller planned a procedure of vertical separation between ACA109 and MAL7072, whereby he would maintain 1,000 feet between them; hence his instruction for ACA109 to maintain 2,000 feet. To the controller, his plan was seemingly set in place when ACA109 acknowledged that instruction. The in-flight circumstances which rapidly developed and ultimately led to the loss of separation could have been avoided had ACA109 descended to 2,000 feet before it missed the approach clearance and flew through the localizer.

The arrival controller identified a developing traffic conflict between ACA109 and MAL7072 when he challenged ACA109 as it approached the localizer for runway 08L. At this time, there was ample room for the

controller to manoeuvre the aircraft to maintain the required separation standard of either 1,000 feet vertically or 3 nm horizontally. His corrective actions were appropriate and would have prevented the loss of separation had ACA109 reacted correctly and in a timely fashion to his instructions to turn to a heading of 230° and maintain 2,000 feet. The command itself, however, was not sufficiently imperative to elicit an immediate response from the pilot, since the word “maintain” does not imply any level of immediacy or urgency. Nevertheless, the controller did use language that inferred priority of action; however, the pilots initially did not perceive that inference.

Once ACA109 crossed the localizer and did not follow the flight path anticipated by the controller, the last procedural safe-guard available to the controller would have been vertical separation; it was, however, negated owing to ACA109 still being at 3,000 feet, and continuing to remain at that altitude until well after the loss of separation had occurred. In these circumstances, the controller had no other option than to issue significant heading vectors to the aircraft to place them on diverging headings – a course of action that prevented the risk of collision.

Findings

1. The pilot of ACA897 accepted and read back the approach clearance intended for ACA109.
2. The pilots of ACA109 did not recognise that ACA897 had read back the clearance intended for ACA109.
3. The controller did not detect the incorrect call sign when ACA897 read back the clearance intended for ACA109.
4. The captain of ACA897 accepted a clearance which would have allowed the aircraft to descend below a minimum safe altitude.
5. Without ATC instruction, ACA109 began a left turn after crossing the localizers.
6. The controller took appropriate and timely action when he recognised a developing loss of separation.
7. The captain of ACA109 thought the controller had instructed him to turn to 130°, when it was 230°.
8. ACA109 did not descend in a timely manner, and the resultant delay contributed directly to the loss of separation.
9. The controller did not use the safety-alert terminology outlined in MANOPS.

10. A loss of separation occurred when ACA109 turned left into the protected airspace of MAL7072 at the same altitude.
11. There was no risk of collision.

Causes and Contributing Factors

The loss of separation occurred as a result of ACA109 turning left after crossing the localizers and not descending when instructed by the controller. Contributing to the incident were pilot-controller hearback/readback errors, incorrect educated expectations, incorrect assumptions, and reduced situational awareness.

Safety Action

In light of this and other similar occurrences, the TSB forwarded an Aviation Safety Advisory to Nav Canada concerning the lack of use by controllers of appropriate safety alert phraseology in situations which should elicit a sense of urgency or immediacy. The Advisory suggested that Nav Canada may wish to place greater emphasis on the use of standard safety alert phraseology in situations in which ATC separation standards have been breached or in which there is imminent danger of collision between two aircraft or between an aircraft and the terrain.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 22 April 1998.