

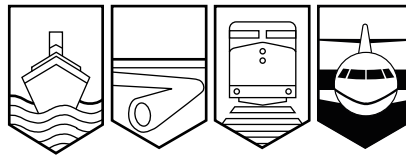
Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A02C0079



RISK OF COLLISION

NAV CANADA

WINNIPEG AREA CONTROL CENTRE

PRINCE ALBERT SECTOR

SASKATOON, SASKATCHEWAN 50 nm E

25 APRIL 2002

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

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Summary

A Korean Airlines Boeing 747-200 (KAL231) was en route from Anchorage, Alaska, to Chicago, Illinois, at flight level (FL) 330. A British Airways Boeing 747-400 (BAW284) was en route from San Francisco, California, to London, England, also at FL330. The planned tracks of the two aircraft crossed approximately 63 nautical miles (nm) east of Saskatoon, Saskatchewan, and the aircraft would have reached the crossing point at about the same time. At approximately 2130 local time, when the aircraft were both approximately 10 nm from the crossing point, the Prince Albert sector controller realized that a conflict was about to occur. The Prince Albert sector controller asked KAL231 for its heading and then instructed KAL231 to turn left and to descend to FL310. After KAL231 acknowledged these instructions, the Prince Albert sector controller asked BAW284 for its heading and then instructed BAW284 to turn right now. KAL231 crew then queried their instruction to descend and were instructed to descend now. Both aircraft crews then correctly complied with their instructions. The minimum distance between the two aircraft during the manoeuvring decreased to approximately 7.9 nm laterally and 700 feet vertically. Although the required separation of 5 nm was maintained, there had been no planned separation between KAL231 and BAW284, and safety was not assured throughout the incident.

Ce rapport est également disponible en français.

Other Factual Information

The Prince Albert (PA) sector is one of three high level sectors in the Saskatchewan specialty of the Winnipeg area control centre (ACC). The sector was staffed by one controller and was considered to be fully staffed in accordance with Nav Canada determined levels for the light to moderate level of traffic in the sector. There were 12 aircraft flight data strips on the sector's data board at 2131 central daylight time (CDT)¹, the time of the occurrence. There was a supervisor on duty; however, he was out of the operations room on a scheduled break when the incident occurred. The controller had started his shift at 1515 and assumed control of the PA sector at 2054.

The north half of the PA sector is a transition zone for reduced vertical separation minima (RVSM), which had been introduced three weeks before the occurrence. Aircraft certified for RVSM operations were identified by an annotation on the flight progress strip and by a distinctive radar target symbol.

Controllers scan flight progress strips for potential conflicts when an initial estimate for a new aircraft is received from another sector. The initial estimate is the controller's cue to begin the conflict prediction sequence, which consists of scanning for aircraft with conflicting altitudes and tracks, identifying potential conflict points for these aircraft, and comparing time estimates for these conflict points. This process is repeated until all potential conflicts have been ruled out. If the traffic will enter the RVSM transition area, the controller must also differentiate between RVSM and non-RVSM aircraft. Should a potential conflict be identified that cannot be immediately corrected, the flight progress strips for both aircraft are marked with a red "W" prior to being placed on the active portion of the sector's flight data board. This cues the controller to monitor the conflict and to rectify the situation at a later time.

The *Air Traffic Control Manual of Operations* (ATC MANOPS), Part 9, Flight Progress Strip Marking, paragraph 901.3, contains the following note:

The objective is to post each strip depicting the aircraft's route of flight under the most appropriate fix designator, so that potential conflicts can be more easily recognized and accurately assessed.

The proliferation of random routes has significantly increased the number of potential crossing points, and introducing fix designators (headers) for each of these points was considered unwieldy. The consolidation of all flight progress strips under one header was considered to ease the controller's workload by reducing the task of maintaining and updating the flight progress strips. The PA sector flight data board has a number of headers where flight progress strips may be posted. It is a common practice in this sector to post all flight progress strips under the Saskatoon header. The single header operation used by the controller required him to search through all 12 flight progress strips to identify potential conflicts, a task which he did not complete for British Airways Boeing 747-400 (BAW284) and Korean Airlines Boeing 747-200 (KAL231).

¹ All times are CDT (Coordinated Universal Time minus five hours) unless otherwise noted.

At 2054, when the controller assumed responsibility for the PA sector, the flight progress strip for KAL231 was already on the data board under the Saskatoon header. KAL231 would proceed eastbound through the sector at FL330, estimating the PA sector west boundary at 2112 and Saskatoon at 2127.

At approximately 2056, the PA sector controller received an estimate of 2131 for BAW284 to pass the YOUNG intersection at FL330. He then posted the flight data strip for BAW284 under the Saskatoon header. The YOUNG intersection, 63 nautical miles (nm) east of Saskatoon, was the crossing point for the tracks of KAL231 and BAW284. The controller did not calculate a YOUNG estimate for KAL231. The PA sector controller began scanning for potential conflicts between BAW284 and other aircraft but, before the task was complete, his attention was diverted to accept a hand-off for another aircraft. The controller did not cock the progress strip to indicate that scanning for potential conflicts had not been completed for BAW284. The PA sector controller subsequently turned his attention to re-programming preset preferences on the radar situational display; the presets had been erased during a software upgrade the previous evening.²

The PA sector controller did not resume checking for conflicts between BAW284 and other aircraft in the PA sector and did not detect that KAL231 and BAW284 would reach the YOUNG intersection at the same time and altitude. Consequently, the flight progress strips for the two aircraft were not marked with a red "W" to indicate a conflict, and no other cue was available to draw the PA controller's attention to these aircraft.

At 2111, the PA sector controller established radio contact with KAL231, and determined there was no conflicting traffic in the immediate vicinity of the aircraft. Over the next 13 minutes, the PA controller coordinated the movement of nine aircraft and engaged in a three-minute interchange with Air Canada Flight 129, in response to a request for hockey playoff scores. At 2124, the PA sector controller assumed control of BAW284 and established radio contact with the flight crew. There was no conflicting traffic in the immediate vicinity of BAW284.

At 2126, KAL231 passed the Saskatoon fix (see Appendix A). The PA sector controller calculated that KAL231 would cross the Yorkton fix at 2144 and then performed tasks involving three other aircraft. He did not check for conflicts between KAL231 and other aircraft.

At 2130, when KAL231 was 18 nm northwest of BAW284, the PA sector controller scanned the radar and noticed a conflict between the two aircraft. He contacted KAL231 at 2130:23, determined that the aircraft heading was 096°M, and immediately instructed KAL231 to turn left to 060°M and descend to FL310. The PA sector controller then communicated with BAW284, determined that the aircraft heading was 025°M, and instructed BAW284 to turn right to a heading 050°M. Radar data show that KAL231 turned left at 2130:57 and BAW284 turned right at 2131:17. However, KAL231 did not commence a descent until after a second instruction was issued by the PA sector controller some 23 seconds after the first instruction.

The radar situational display has software tools to determine if a conflict may occur between two or more radar targets. The PA sector controller routinely used these tools, but they were not used to check for a conflict between BAW284 and KAL231. Automatic conflict detection software was not implemented in the Winnipeg ACC.

² Controllers use presets to quickly configure a radar display to individual preferences.

The ATC MANOPS includes a number of references to guide controllers on the use of clear and imperative language when reacting to time critical situations. Article 507.1 instructs 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 specific phraseology to be used is "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)." Other references in Part 1 General and Part 2 Communications refer to the use of the word "immediate" if expeditious compliance is required, or "expedite" to mean "comply with this instruction as promptly as possible". The PA sector controller did not initially use clear and imperative control instructions with KAL231 and he did not pass traffic information to either aircraft until queried by the crew of BAW284.

Nav Canada Air Traffic Services Bulletin 9801, concerning safety alert phraseology, was issued in response to TSB Aviation Safety Advisory 970038, which suggested that Nav Canada find additional means of emphasizing the special need for standard safety alert phraseology. Nav Canada made this subject a mandatory portion of the refresher training given to controllers in 1998/1999. The PA sector controller received this training in 1999. TSB occurrence reports A98H0002 and A01C0155 have also identified the importance of using clear and imperative control instructions in time critical situations.

Nav Canada rules and procedures require controllers to provide full-time attentive flight monitoring. Full-time attentive flight monitoring includes the following: monitoring the radar display, exchanging flight plan data and estimates with other control agencies, and updating flight progress strips. Controllers in the Saskatchewan specialty sectors frequently work alone.

A number of tasks have been shown to increase the probability of an omission type error³, in particular: those with a higher number of discrete steps in an operation; those which involve greater cognitive loading for each procedural step; and those in which the steps in a procedure are not directly cued by the previous step. Further, people who do highly automated or routine tasks are particularly vulnerable to omissions resulting from interruptions, which cause them to lose their place in the process or to exit the process prematurely, particularly when the next job is close at hand.

Analysis

The PA sector controller's attention was diverted to another aircraft before completing the initial conflict detection sequence for BAW284. After the initial scan for conflicts was interrupted, the PA sector controller likely formed an expectation that there were no conflicts between BAW284 and KAL231. The existence of this belief is demonstrated by his engagement in non-control transmissions, by the time spent re-entering preferences on the radar display, and by not employing radar situational display functions to check for a conflict between the two aircraft. There was no automatic conflict alert system and, because the PA sector controller was working alone, there was no human redundancy to alert him to the developing conflict.

Checking for conflicts is a routine task for controllers; the number of steps in the process and the cognitive load increases with traffic density and complexity. Although traffic density in the sector was light to moderate, various factors increased the cognitive load imposed on the

³ Reason, J. (1990). *Human Error*. New York: Cambridge University Press.

controller. The practice of placing all flight progress strips under one header required the controller to review all 12 flight progress strips under the single header in order to identify potential conflict. The controller had estimates for KAL231 over Saskatoon and for BAW284 over the YOUNG intersection, some 63 nm east of Saskatoon. Because the controller had not identified that the YOUNG intersection was a common estimate point for the two occurrence aircraft, when he received the YOUNG estimate for BAW284, he did not calculate a YOUNG estimate for KAL231. As a result, there was no conflict warning annotation placed on the flight progress strips of the two aircraft. The controller did not complete the manual task of conflict detection and did not become aware of the conflict between BAW284 and KAL231 until the aircraft were 14.5 miles apart, on intersecting tracks, and at the same altitude.

The recent implementation of RVSM airspace in the PA sector also contributed to the number of steps and cognitive complexity of the conflict prediction sequence. Although the RVSM airspace was not directly involved in this occurrence, its management requires additional operations by the controller and therefore increases the probability of omission errors.

The PA sector controller did not use clear and imperative control instructions to emphasize the urgency of the situation, nor did he issue traffic information to either of the aircraft involved; this likely contributed to the 23 second delay before KAL231 began to descend.

Findings as to Causes and Contributing Factors

1. The Prince Albert (PA) sector controller did not monitor the flight progress strips in sufficient detail to determine that a conflict would occur between two aircraft. As a consequence, there was no planned separation between Korean Airlines Boeing 747-200 (KAL231) and British Airways Boeing 747-400 (BAW284).
2. The PA sector controller did not adequately use the conflict prediction tools on the radar situational display. As a consequence, detection of the developing conflict and air traffic control intervention to prevent a conflict from occurring was delayed.

Findings as to Risk

1. Clear and imperative control instructions were not used by the PA sector controller to emphasize the urgency of the heading and altitude change instructions to the aircrew, nor was traffic information passed. As a result, the situational awareness of the aircrew may have been degraded and the desired reaction to the controller's instructions delayed.
2. The reduced use of fix designators as flight progress board headers could require the controller to review more flight progress strips in order to detect potential conflicts and may make it more difficult to detect conflicts by reference to the flight data board.
3. Automatic conflict detection software was not installed in the Winnipeg area control centre (ACC).

Safety Action

Conflict alert functionality is now operational in high-level airspace controlled by Moncton, Winnipeg, Gander, and Edmonton ACCs.

Because of software issues not related to conflict alert, Toronto, Montreal, and Vancouver have not yet implemented conflict alert. These software issues were resolved in December. The installation of the software has taken place at all three units, paving the way for conflict alert implementation.

It is anticipated that controller conflict alert training will commence shortly in Toronto, with implementation in high-level airspace of the North Enroute speciality to follow. Conflict alert coverage will be expanded to other high-level sectors in Toronto as controller training progresses. Firm dates have not yet been set for implementation in Montreal and Vancouver; however, it is expected that the process will move quickly once controller training is underway.

The Edmonton trials in low-level airspace have demonstrated that the current conflict alert functionality is suitable for use at and above 14 000 feet with the exception of terminal control airspace. As a result, implementation planning for low-level deployment will get underway in the near future.

Nav Canada indicated that they will be undertaking a number of initiatives to ensure controllers react appropriately, in a timely manner, and with the correct information to aircrew to minimize the risk of collision potential in a loss-of-separation occurrence. These initiatives include the following:

- reviewing the current safety alert phraseology as published in the *Air Traffic Control Manual of Operations (ATC MANOPS)* with a view to developing, if required, additional phraseology for use by controllers in a loss of separation situation;
- inclusion of the concept of clear and imperative control instructions into basic and refresher training, including specific controller action in the event of a loss-of-separation; and
- publication of an ATS Bulletin that will highlight the importance of correct and timely action by controllers to resolve a conflict situation with the use of clear and imperative instructions that includes both corrective action and traffic information to all involved aircraft.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 20 February 2002.

Appendix A - Route of Flight

