

Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A09P0096



LOSS OF SEPERATION

NAV CANADA – VANCOUVER AREA CONTROL CENTRE
PENTICTON, BRITISH COLUMBIA, 20 nm SW

24 APRIL 2009

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 – Vancouver Area Control Centre
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Summary

On 24 April 2009 at 1258 Pacific Daylight Time, a Canadian Forces Canadair CL600 aircraft, (registration CC144618, serial number 5535), operating as CFC3016, was en route from Vancouver, British Columbia, to Ottawa, Ontario, climbing to flight level (FL) 370. A United Arab Emirates Boeing 777-200LR aircraft (registration A6-EWA, serial number 35572), operating as UAE215, was en route from Dubai, United Arab Emirates, to Los Angeles, United States of America, cruising at FL370. When the aircraft were about 20 nautical miles southwest of Penticton, British Columbia, the controller received an automated radar conflict alert signal indicating that, in one minute, the aircraft would lose the required five nautical miles radar separation at the same altitude. The controller issued instructions for CFC3016 to descend to FL360 and to turn right 30° and instructed UAE215 to turn left 30°. Both aircraft received traffic alert and collision avoidance system (TCAS) warnings. UAE215 received a TCAS resolution advisory and responded to it by climbing. When the aircraft closed to within five nautical miles horizontally, there was a 500 feet vertical separation between them, rather than the required 1000 feet.

Ce rapport est également disponible en français.

Other Factual Information

Both aircraft were under the control of the Vancouver Area Control Centre (ACC), Mountain High Specialty which includes all airspace at flight level (FL) 260¹ and above in the eastern portion of the Vancouver Flight Information Region.

The sector controller was certified and qualified in accordance with existing regulations. The controller had been employed at the Vancouver ACC for about 20 years. The occurrence controller had been off duty for the previous two days and was scheduled to be off duty for the next two. The controller's shift began at 1230² and the controller had been on duty for 28 minutes prior to the occurrence and in position for 20 minutes. The controller was responsible for the radar and data positions. At the time of the loss of separation, the controller was working four aircraft. Traffic was neither heavy nor complex.

Description of Events

The controller recognized the potential crossing track³ conflict shortly after taking over the position, when UAE215 came on frequency at 1237. Having scanned the flight progress strips, the controller noted that both aircraft were to be at FL370 in the vicinity of the Princeton (YDC) VOR (very high-frequency omnidirectional range) with less than ten minutes of separation. The controller planned on issuing UAE215 a routing change that would result in a westerly track and, as such, make it possible to climb UAE215 to FL380, an altitude appropriate to the direction of flight. This would resolve the conflict and the controller thought it unnecessary to annotate the two flight progress strips with the red W.⁴

The actual routing change, however, did not result in UAE215 achieving a westerly track and the controller did not issue a climb to UAE215. The controller then intended to find a more direct route for UAE215 later but did not execute this plan. The controller's attention was then diverted to other traffic in the sector and the conflict between CFC3016 and UAE215 went unresolved.

At 1248:00, CFC3016 made initial contact with the sector controller as it was climbing from FL290 to FL370.

Conflict Alert System

The conflict alert system (CAS) is a function of the radar data processing system that examines radar tracks for potential conflicting traffic. Based on three dimensional predicted positions, tracks are evaluated to determine if separation standards will be violated within a specified time. Alerts are generated and sent to the displays in two stages. Sixty seconds before loss of separation is predicted, a traffic alert is generated. A conflict alert is generated after separation is lost. Controllers use the CAS to identify potential conflicts where a loss of separation may occur. The system for enroute radar airspace above 14,000 feet warns a controller when a potential conflict is developing.

Source: NAV CANADA Conflict Alert DSC Manual, version 3.1, and NAVCANADA News Backgrounder August 2008.

¹ Approximately 26,000 feet.

² All times are Pacific Daylight Time (coordinated universal time minus seven hours).

³ The *Air Traffic Control Manual of Operations* (ATC MANOPS) defines crossing track as: "a term used in the application of separation, indicating tracks that converge or diverge at an angle of 45 degrees to 135 degrees inclusive."

⁴ A red W (for warning) on appropriate flight progress strips is used to identify, amongst other things, any confliction with other aircraft.

At 1258:13, the controller received an automated radar conflict alert (CA) signal of traffic (TFC) on the data blocks of both aircraft accompanied by an audible tone and a change in the shape of the present position symbol of the aircraft to a yellow cartwheel symbol. This indicated that, without controller intervention, the required five miles radar separation for aircraft flying at the same altitude would be lost in 60 seconds.

At 1258:22, the controller instructed CFC3016, which had reached FL370, "for traffic, descend now, flight level 360." The crew acknowledged the instruction, set the altitude selector and adjusted the vertical speed to 1000 feet per minute as per Canadian Forces procedures. At 1258:31, the controller then instructed CFC3016 to turn right, and this instruction was also acknowledged by the crew.

At 1258:39, the controller instructed UAE215 to turn left. No acknowledgement from the crew was received and so, at 1258:45, the controller re-issued the turn. At 1258:51 UAE215 began the process of changing heading. (See Appendix A – Aircraft Flight Paths).

At 1258:56, the controller instructed CFC3016 to expedite its descent. CFC3016 responded that its descent rate was almost 1000 feet per minute and that it had received a traffic alert and collision avoidance system (TCAS) traffic advisory (TA). The crew of UAE215 attempted to acknowledge the controller's instruction to turn during these communications and was not heard by the controller.

At 1259:02, the TCAS on UAE215 issued a resolution advisory (RA) to climb. The crew responded and, at 1259:09, advised the controller. At 1259:14, the controller again instructed UAE215 to turn left.

At 1259:33, vertical spacing of 1000 feet had been achieved between the two aircraft at which point the horizontal spacing was 1.8 nm. The minimum required spacing was 1000 feet vertically or 5 nm horizontally. The turns issued to the aircraft resulted in UAE215 directly overflying CFC3016 (see Appendix A – Aircraft Flight Paths).

The TCAS is an airborne system that alerts flight crews to other aircraft in their vicinity that pose a potential collision hazard. TCAS equipment interrogates other aircraft transponders to determine their range, bearing and altitude. The TCAS generates a traffic advisory (TA) when another aircraft is approximately forty seconds from the point of closest approach. A resolution advisory (RA), in the form of a vertical manoeuvre, is generated when the other aircraft is approximately 25 seconds from the point of closest approach. The RA provides a vertical restriction or manoeuvre to maintain or increase separation.

On the topic of descent, subsection paragraph 8.5.1 (a) of Transport Canada's *Aeronautical Information Manual* (TP14371) suggests the following:

When an altitude clearance is issued, the pilot should begin climb or descent promptly on acknowledgement of the clearance. The climb or descent should be made at an optimum rate consistent with the operating characteristics of the aircraft. If the above is not the case, or if it becomes necessary to stop the climb or descent, the pilot should advise ATC of the interruption or the delay in departing an altitude.

Recorded radar data showed that CFC3016 began its descent 36 seconds after the descent instruction was given.

It took three transmissions over a 35-second period for the controller to receive an acknowledgement from UAE215, by which time the flight had begun to manoeuvre in response to the TCAS RA. Although UAE215 acknowledged the second turn instruction the controller did not receive this transmission as it was blocked.

Flight Progress Strips

Flight progress information is recorded on flight progress strips – in paper or electronic formats. In this instance, essential flight plan information was printed on paper strips that are annotated by the controller (see Figure 1). Flight progress strips serve many purposes:

- as a record of clearances and instructions;
- as a back-up in the event of some failure that would invoke the use of procedural separation techniques;
- as an aide-memoire; and
- as a planning and decision-making tool.

To alleviate the problem of different handwriting, specific symbology is used; an entire section of the ATC MANOPS is devoted to strip writing.⁵

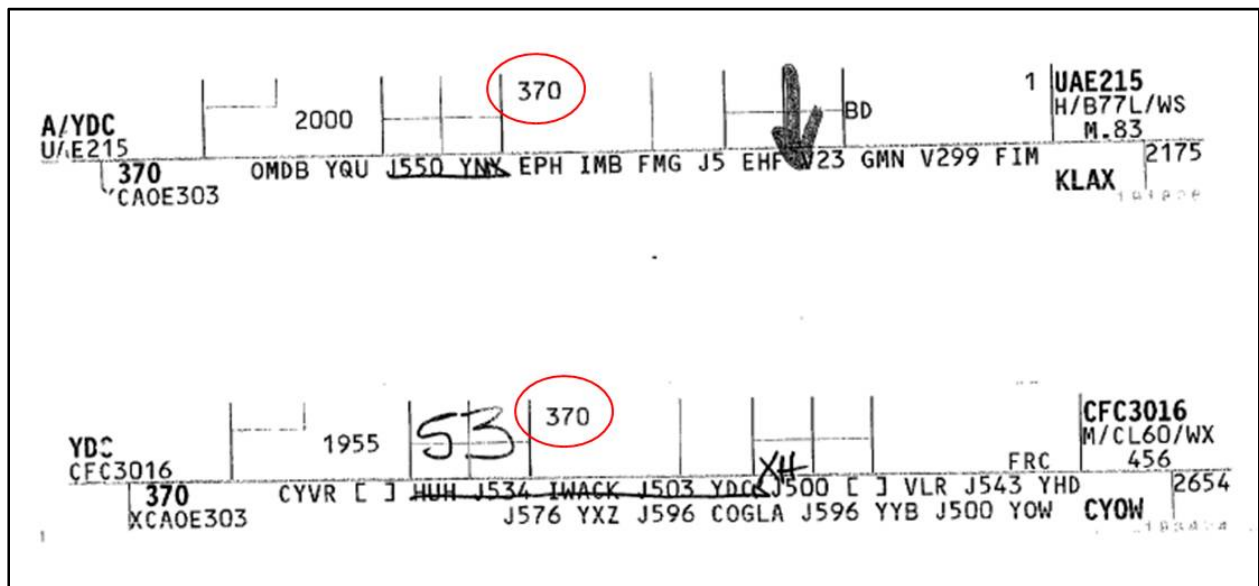


Figure 1. Flight Progress Strips showing flight levels

In part, ATC MANOPS section 902.5 required, at the time of the occurrence, that a red warning indicator be affixed to a strip as follows:

post a red “W” on appropriate flight progress strip(s) if corrective action will be necessary, to identify any conflict with other aircraft; or to identify any other hazardous or critical situation;

⁵ ATC MANOPS, Part 9.

post the warning indicator in the box that most clearly indicates the reason for the warning. As necessary, enter sufficient details (i.e., aircraft identification, conflict point(s), time(s), etc.) to clearly identify the confliction;
circle the altitude in red on the appropriate flight progress strip(s) if an altitude not appropriate to the direction of flight is assigned; and
draw a single line through the warning indicator when it is no longer required.

Strips are displayed on boards under designators. These designators indicate either the actual geographical relationship of the fixes as viewed on airway charts or the altitudes. Doing so facilitates conflict recognition. In this instance, the flight progress strips of both flights were posted under the YDC (Princeton) designator in reference to the aircrafts' geographical relationship.

In terms of board management, section 901.6 (d) of ATC MANOPS provides direction to leave active strips in a cocked ⁶ position if other potential situations requiring investigation or further action exist.

Further, section 901.8 of ATC MANOPS requires a controller to scan the control data board by performing the following actions:

- scan each bay individually rather than looking over the entire board;
- check altitude boxes in each bay to verify vertical separation;
- check strips to ensure some other form of separation exists if more than one aircraft is at the same altitude.

Flight progress strips are distributed to appropriate sectors at least 15 minutes prior to transfer of control to the controller. Shortly after the controller took over the position and UAE215 was transferred to the control of the Mountain High Specialty, the controller noted from the printed flight progress strips in the strip bay that both aircraft would be at FL370. The controller had identified the potential problem between CFC 3016 and UAE 215 which were both cleared to FL370 and on crossing tracks. Contrary to ATC MANOPS, red Ws had not been posted on the flight progress strips. It is unknown whether the flight progress strips were cocked.

⁶ The cocking of flight progress strips is an essential control technique used to remind controllers that some type of further action must be performed – ATC MANOPS 901.6, note 1.

Imperative Phraseology

In December 2003, NAV CANADA issued an urgent Air Traffic Services (ATS) Operational Publication Change concerning an amendment to subsection 507.1 of ATC MANOPS introducing the adoption of International Civil Aviation Organization (ICAO) phraseology for safety alerts. This subsection directs controllers to use specified safety alert phraseology when they are aware that an aircraft is at an altitude which, in their judgment, places it in unsafe proximity to another aircraft. In 2004, NAV CANADA issued an Air Traffic Services Bulletin – Squawk 7700 (2004-1) titled *Imperative Phraseology*, which underscored the importance of using phraseology that includes both corrective action and traffic information to all aircraft in a loss of separation occurrence.

When the controller issued descent and turn instructions to CFC3016 and turn instructions to UAE215, the controller did not use imperative phraseology, nor did the controller provide specific traffic information or request immediate action. There was nothing in the controller's intonation that conveyed a sense of urgency. CFC3016 acknowledged the controller's instruction and began the altitude change procedure, but no change in the aircraft's track or altitude was observed for 36 seconds. UAE215 acknowledged the controller after the second turn instruction but the transmission was blocked by another communication. It was not until 35 seconds later that the controller became aware that the crew of UAE215 was following a TCAS RA to climb.

Since 2005, the TSB has investigated three other occurrences in which the NAV CANADA radar CA function indicated approaching losses of separation (A08W0151, A07W0072, and A06C0113). In those occurrences, the controller instructed the flight crews to manoeuvre to maintain separation. The TSB found, however, that the avoidance instructions were not given with sufficient urgency to avoid losses of separation.

ATC Radar Conflict Alerts

The goal of the 60-second radar traffic alert is to warn controllers of an impending separation loss so that it may be resolved ahead of any airborne TCAS advisories which are typically generated approximately forty seconds ahead of the estimated closest point of approach. This amount of time was judged by NAV CANADA to be optimal to avoid excessive nuisance alerts and provide the controller with sufficient time to issue instructions to regain separation or prevent a collision.

In 2005 the TSB investigated an occurrence (A05W0248) in which the controller, after having received a radar TFC alert, issued instructions to the flight crews to manoeuvre to avoid a collision. The TSB found that, in some circumstances, the 60-second warning may not provide enough time for a controller to issue instructions to prevent a loss of separation.

Controller Response to TCAS RA action

To attempt to maintain and then regain separation, the controller issued both descent and turn instructions to CFC3016 and turn instructions to UAE215. After UAE215 informed the controller that it was conducting a TCAS climb, the controller again issued a turn.

Subsection 127.2 of the ATC MANOPS, which was current at the time of this incident, stated that controllers are to:

Provide relevant traffic information and collision avoidance advice as appropriate to an aircraft under your jurisdiction if you are advised by the aircraft that it is responding to an ACAS⁷/TCAS resolution advisory or GPWS⁸/TAWS⁹ warning. Do not issue control instructions that would contradict an aircraft's resolution advisory or warning.

Neither CFC3016 nor UAE215 were provided with specific traffic information.

As a result of a separate incident, the ATC MANOPS has since been amended and now states:

If you are advised by an aircraft that it is responding to an ACAS/TCAS resolution advisory or GPWS/TAWS warning: A. Do not attempt to modify the aircraft flight path until the pilot reports returning to the terms of the current ATC clearance or instruction; and B. Provide relevant traffic and collision avoidance information as appropriate.

Analysis

The controller identified the conflict between CFC3016 and UAE215 early on. The controller resolved to change UAE215's route toward the west and issue a climb to FL380. A solution in hand, the controller did not think it necessary to mark the flight progress strips with the required red W. Thus, an important aide-memoire was not used. The controller's attention became focused on other traffic in the sector. The conflict went unresolved until the TFC CA sounded.

The controller's solution required two parts: a heading change and an altitude change. The altitude change was dependent upon identifying that a westbound track change had been achieved. A two-part resolution to the conflict requires a means of remembering that a second part must be performed in order to resolve the conflict. The use of the red W serves to remind the controller that the conflict has yet to be resolved. As the controller did not use this aide-memoire, the altitude change was not completed.

In circumstances where time is critical, the use of imperative phraseology is intended to alert flight crews of the need for immediate action. The controller did not use imperative phraseology, nor was there anything in the controller's voice that conveyed a sense of urgency. Consequently, the air crews reacted in a non-urgent way; CFC3016 did not begin descent for 36 seconds.

The controller cleared CFC3016 to turn right, and UAE215 to turn left. The geometry of this crossing track conflict was such that the turns resulted in one aircraft flying directly overtop of the other. The turns issued by the controller were ineffective in establishing the minimum lateral radar separation. Altitude spacing was achieved by the controller's initial descent instruction to CFC3016 and UAE215's response to the TCAS RA.

⁷ Airborne Collision Avoidance System.

⁸ Ground Proximity Warning System.

⁹ Terrain Awareness and Warning System.

The TFC CA sounded as designed. The 60-second warning may not provide enough time, however, to resolve conflicts if:

- time is lost in decision-making;
- time is lost in issuing instructions; or
- time is lost by air crews who do not act in a timely fashion.

Though manoeuvring instructions were given to CFC3016 within nine seconds of the TFC alert, the aircraft did not begin descent quickly enough to avoid a loss of separation. The two aircraft closed to the point where UAE215's TCAS RA was generated, which the flight crew was then compelled to follow.

The controller continued to issue turn instructions to UAE215 after being advised that it was responding to a TCAS advisory. No specific traffic information was communicated to either aircraft.

Findings as to Causes and Contributing Factors

1. The controller recognized the conflict between CFC3016 and UAE215 when taking control of UAE215 but did not use a required aide-memoire and take sufficient action early on to maintain separation.
2. The controller did not use imperative phraseology when he instructed the involved aircraft to commence avoiding action; this likely delayed the reaction of the crews to the instructions and resulted in a prolonged period of risk of collision.
3. The turns issued to the two aircraft did not resolve the loss of separation.

Other Finding

1. In some circumstances, the 60-second traffic conflict alert (TFC CA) may not provide enough time to resolve conflicts.

Safety Action Taken

The TSB issued Aviation Safety Letter A09P0096-D1-A1 *Adequacy of Automated Radar Conflict Alert Warning Times* on 25 January 2010 to NAV CANADA, stating that it may wish to examine the feasibility of extending the 60-second warning time in order to provide additional time for controllers to issue instructions to maintain the required separation and to provide flight crews with additional time to manoeuvre, reducing the likelihood of a traffic alert and collision avoidance system resolution advisory (TCAS RA) being issued.

In its reponse dated 01 March 2010, NAV CANADA expressed concern that extending the warning time will result in nuisance alarms, particularly in situations where aircraft are climbing and/or descending and will level off prior to a conflict, but not in time to prevent an alarm. NAV CANADA indicated that the implementation of the Canadian Automated Air Traffic Control System (CAATS) will eventually resolve this problem of nuisance alerts prior to level-off. NAV CANADA undertook to consider the feasibility of extended warning times once CAATS has been modified to take into account aircraft that will be levelling off prior to any conflict.

NAV CANADA has begun a review of the requirement for mandatory use of safety alert phraseology associated with the Conflict Alert feature. In the spring of 2010, information was gathered on Conflict Alert software as well as International Civil Aviation Organization, Federal Aviation Administration and other states' air traffic control (ATC) procedures. As a result, a draft ATC Directive has been prepared on the mandatory use of safety alert phraseology in Canadian airspace. This directive will be studied by a working group composed of ATC operational subject matter experts that will meet in Ottawa during the fall of 2010. The working group will proceed in accordance with the NAV CANADA Safety Management System.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 26 October 2010.

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Appendix A – Aircraft Flight Paths

