Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A06C0113

LOSS OF SEPARATION

NAV CANADA
EDMONTON AREA CONTROL CENTRE – SHIELD SPECIALTY
The PAS, MANITOBA, 42 nm NE
15 JULY 2006

Canada

Aviation Investigation Report

Loss of Separation

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Summary

Northwest Airlines Flight NWA26, a Boeing 747-400 with 16 crew members and 401 passengers on board, departed Tokyo, Japan, and was cruising en route to Detroit, Michigan, United States, at flight level 370. Air Canada Flight ACA185, an Airbus A319-100 with 5 crew members and 116 passengers on board, departed Halifax, Nova Scotia, and was cruising en route to Calgary, Alberta, at flight level 360. Both aircraft were under radar control of the Thompson sector in the Shield specialty of the Edmonton Area Control Centre, and both had direct controller–pilot communications on 133.5 MHz. The sky was clear, with excellent visibility.

At 1002:36 mountain daylight time, ACA185 was instructed by the Thompson sector air traffic controller to climb to flight level 380. At 1004:06, while ACA185 was climbing through flight level 367, the Thompson sector's conflict alert system issued a traffic alert regarding ACA185 and NWA26, and the controller issued instructions to resolve the conflict. However, before the flight crews responded to the controller's instructions, the traffic alert and collision-avoidance systems on each of the two aircraft issued a resolution advisory to the flight crews for NWA26 to climb and ACA185 to descend. The crews responded to the resolution advisory, and the aircraft passed with 0.7 nautical mile horizontal spacing with ACA185 at flight level 354 and NWA26 at flight level 376. The required minimum separation standard was five nautical miles horizontally or 1000 feet vertically.

Ce rapport est également disponible en français.

Other Factual Information

General

The Thompson sector controller held a valid air traffic controller licence and was certified and qualified for the Thompson sector in accordance with existing regulations. The controller had been employed at the Edmonton Area Control Centre (ACC) for six years. The controller had worked initially in the North High specialty for four years, followed by one year in the Shield specialty, one year in the North High specialty again, and again in the Shield specialty for three months before the occurrence.

Immediately before the day of the occurrence, the controller was on days off and leave for 13 days. The controller started his shift at 0730 mountain daylight time,[1] and at the time of the occurrence, had been on duty for about 2.5 hours. The controller had a 56-minute rest break before taking over the Thompson sector, and had been working for 34 minutes at the Thompson sector at the time of the occurrence.

The Edmonton Shield specialty airspace was Class A controlled airspace at flight level (FL) 290 and above and was divided into three sectors: Bison, Severn, and Thompson (see Appendix A). On the morning of the occurrence, the Severn and Thompson sectors were initially combined as Severn. At 0928, the Thompson sector was split from Severn. The controller received a handover briefing from the previous controller before taking control of the Thompson sector.

At the time of the occurrence, the Shield specialty had four controllers and one supervisor on duty, as required by unit staffing guidelines. Three of six control positions were open in the Shield specialty: the supervisor was in the Bison sector; a second controller was in the Severn sector; and the occurrence controller was in the Thompson sector. The three controllers were working both the radar and data positions in each sector. Staffing of sectors is determined by traffic volume, complexity, and the number of controllers available. If traffic volume and complexity warrant it, the sector is staffed with a second controller for the data position.

The other two controllers in the Shield specialty were on breaks. All equipment at the Thompson sector was operating normally. Traffic level was assessed as light to moderate and medium complexity.

Integrated Situational Display System

The Thompson sector was equipped with an integrated situational display system (ISiT). NAV CANADA introduced the ISiT in August 2005 to provide controllers with the ability to control both procedural and radar targets on a single situational display. The ISiT maintains a connection to both a Northern Airspace Display System (NADS) flight data processor (FDP) and a radar data processing system (RDPS). The ISiT depicts non-radar procedural track information fed to it by the NADS, and radar information fed to it by the RDPS.

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1 All times are mountain daylight time (Coordinated Universal Time minus six hours).

In a radar environment, the controller uses the ISiT as the radar display. In a non-radar environment, the controller uses the NADS portion of the ISiT for the display of NADS targets. In general, only the time and altitude separation standards are recognized by the NADS portion of the ISiT. In a radar environment, short-term conflict detection is provided through conflict alert (CA) available on the ISiT display. In a radar environment, there is no medium- or long-term conflict detection.

A conflict predicted by the NADS does not always mean that a true conflict exists or will exist. The NADS is limited to time and altitude separation standards and does not use separation standards such as radar, distance measuring equipment (DME), or global positioning system (GPS) when predicting a conflict. The NADS is purely a procedural system and will continue to show a conflict even if the aircraft are under radar control.

The ISiT provides several tools to assist a controller in identifying potential conflicts, including a predicted track line (PTL) on all targets (PTL ALL), range bearing lines between targets (RBL), and a probe function that tests the track and altitude of a flight plan for conflicts. Controllers are not required to make use of these tools. To use these tools, a controller must manually activate them.

Radar Conflict Alert

Conflict alert (CA) is a function of the RDPS that examines radar tracks for potentially conflicting traffic. Based on three-dimensional predicted positions, tracks are evaluated to determine if separation standards will be violated within a specified time. Tracks determined to have a potential for conflict are then examined with greater frequency. When necessary, alerts are generated and sent to the displays in two stages. Sixty seconds before a loss of separation is predicted, a traffic alert is generated. A conflict alert is generated after separation is lost. RDPS traffic and conflict alerts are displayed only to air traffic controllers.

Flight Progress Strip Warning Indicators

The *Air Traffic Control Manual of Operations* (ATC MANOPS) specifies the warning indicators to be used on flight progress strips to attract a controller's attention to potentially hazardous or critical situations. The flight progress strip is annotated with a red "W" in the area that most clearly identifies the reason for the warning.

Separation Planning

ATC MANOPS defines a loss of separation as "An occurrence in which less than the authorized minimum existed, or in which the minimum was not assured."

Separation between aircraft is maintained by controllers identifying traffic conflicts and then developing, executing, and monitoring a separation plan. When identifying a potential conflict, controllers may use ISiT tools such as PTL and RBL to confirm the conflict. There are no specified standard practices for controllers to use when forming their separation plan, although controller training includes extensive practice to develop planning skills. Because there are no

specified standard practices, controllers develop individual techniques to identify conflicting traffic and develop separation plans. The Thompson sector controller's primary technique to detect conflicts was to visually scan the ISiT display and flight progress strips.

Traffic Alert and Collision-Avoidance Systems

Air traffic controllers receive no information directly from traffic alert and collision-avoidance systems (TCAS). The TCAS operates independently of air traffic control (ATC) and provides traffic alerts (TAs) and resolution advisories (RAs) to flight crews. TAs are intended to help crews see conflicting traffic and to alert them to the possibility of an RA. RAs warn crews of potential collisions and provide descent or climb commands to enable them to avoid an intruder aircraft. The TCAS uses a datalink between aircraft transponders to provide complementary RAs (one aircraft climbing and one aircraft descending). It is possible for an RA to be generated when the two aircraft involved are separated by approved criteria. Because the TCAS does not provide any information to air traffic controllers, it is necessary for flight crews to notify ATC when deviating from a clearance in response to a TCAS RA.

Use of Specified Phraseology

The ATC MANOPS directs controllers to use the phraseology contained in the manual whenever possible, and, in cases where phraseology is not provided, controllers are advised to use plain language that is as clear and concise as possible. The ATC MANOPS directs controllers to avoid issuing control instructions that would contradict an aircraft's RA in the event of notification by a pilot that an RA is in progress.

Controller Use of Decision Support Tools

The ATC MANOPS directs controllers to plan, execute, and monitor all applications of separation. Controller vigilance and situational awareness are required to provide a safe, orderly, and expeditious operation. In some high-level non-radar environments where traffic and complexity warrant, conflict probes are provided to control staff to assist in the determination of appropriate non-radar separation standards where these calculations may be difficult to compute. In radar environments, additional electronic measures such as PTL and RBL have been provided to controllers as decision support tools to assist in developing a plan once a potential conflict has been identified by the controller.

These tools are intended to augment controller vigilance and situational awareness. In addition, short-term conflict alert warning software is available in some locations to provide a measure of protection similar to TCAS in the event that the controller plans fail.

Sequence of Events

At 0842, the Severn controller queried ACA185 as to when the flight could operate at FL 380. The crew members advised the controller that they could climb to FL 380 at 1015, and the controller recorded this information on the ACA185 flight progress strip. At 0925, ACA185 was radar-identified by the Severn controller, and at 0928, the Thompson sector was split from Severn.

Lufthansa Flight DLH456, a Boeing 747-400 en route from Frankfurt, Germany, to Los Angeles, California, United States, was at FL 360 under radar control of the Thompson sector with direct controller–pilot communications on 133.5 MHz. ACA185 and DLH456 were on converging tracks and in conflict at FL 360.

At 0939, the Thompson controller passed estimates to an adjacent sector, indicating that ACA185 would pass abeam The Pas at FL 380 and DLH456 would pass overhead The Pas at FL 360.

The controller's ISiT predicted that the flight path of DLH456 would cross the flight path of ACA185 at about 1017 with less horizontal separation than the NADS system required for aircraft at the same altitude as per the ATC MANOPS. Consequently, the ACA185 and DLH456 aircraft identification elements of the ISiT data tags were displayed in red. The red depiction of the aircraft identification elements did not have any significance in a radar environment and only indicated to the controller that NADS non-radar separation standards would not be met. Because the aircraft were under radar control, radar separation standards applied. However, this information provided a warning to the controller that there was a potential conflict at the point the track crossed. The spacing at the crossing point was specified in NADS criteria rather than radar separation criteria, hence the highlighting of the aircraft identification elements.

The controller had also placed blue range bearing lines on the ACA185 and DLH456 targets. The flight progress strips for ACA185 and DLH456 were marked with a red "W" adjacent to estimates for The Pas very high frequency omnidirectional range (VOR).

Two flights were south-eastbound at FL 370: NWA26 and Northwest Airlines Flight NWA12D, another Boeing 747-400, which had also departed Tokyo, Japan, and was cruising en route to Detroit, Michigan, United States. Both aircraft were flying the same track, with NWA12D about six minutes ahead of NWA26. NWA12D was maintaining Mach 0.86 and NWA26 was maintaining Mach 0.85. Information regarding both NWA26 and NWA12D was displayed on the ISiT and flight progress strips but, as they were not in conflict with other aircraft, they were not emphasized in any way. Both flights were under radar control of the Thompson sector with direct controller–pilot communications on 133.5 MHz.

At 1002:03, ACA185 contacted the Thompson controller to discuss the climb to FL 380, advising the controller that their optimum altitude was FL 355. The controller advised the crew that crossing traffic could not climb, and asked whether ACA185 could accept a climb, and then return to FL 360 in about 10 minutes. ACA185 advised that they could accept a higher altitude.

Flight progress strips for flights under control in the sector were organized by altitude. When the controller scanned the strips, NWA26 at FL 370 was not identified as a potential conflict for the climb of ACA185.

The controller visually scanned the ISiT display, but did not manually activate ISiT tools to assess whether any other aircraft would conflict with ACA185 while climbing to FL 380.

At 1002:36, the controller instructed ACA185 to climb to FL 380, and the crew acknowledged the instruction. This transaction terminated at 1002:50. The instruction for ACA185 to climb to FL 380 was issued about 5 minutes (30 miles) after NWA12D cleared the track of ACA185, and before NWA26 arrived at the crossing point with ACA185. As NWA12D cleared the track of ACA185, the controller scanned the flight progress strips and radar display and confirmed that there was no conflict with NWA12D. The controller did not perceive the conflict between ACA185 climbing to FL 380 and NWA26 at FL 370.

At 1002:52, the controller answered a telephone hotline call from another sector with estimates for two flights that would later enter the Thompson sector. The Thompson controller did not have a flight progress strip for one of the flights, and the two controllers had a brief discussion regarding processing of estimates for flights crossing the southeast corner of the Severn sector. The Thompson controller searched for the flight progress strip, obtained the strip from an adjacent sector workstation, and processed the estimate. This flight progress strip had been routed to a printer at a different sector instead of Thompson, but the investigation did not determine why this occurred. This transaction terminated at 1003:36.

The controller's attention returned from the flight progress strips to the ISiT, and, while scanning the ISiT, the controller perceived the conflict between ACA185 and NWA26 seconds before the ISiT conflict alert system issued a traffic alert for the two flights at 1004:06. The aircraft position symbols for ACA185 and NWA26 changed from a diamond to a wagon wheel shape with a yellow one-minute predicted track line (see Figure 1). The conflict alert should also have issued an aural "Traffic, Traffic" advisory to the controller, but the investigation could not determine whether this occurred. At this time, the altitude of ACA185 was FL 367 and the horizontal spacing between ACA185 and NWA26 was about 14 nm.

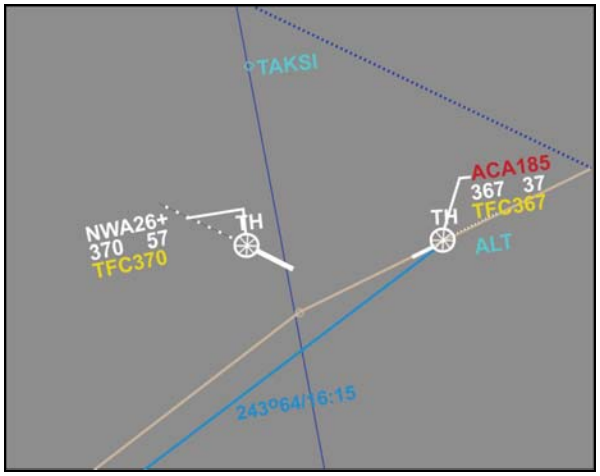

Figure 1. Close-up view of ISiT conflict alert

The controller decreased the range on the ISiT to better display the two flights and, at 1004:10, instructed ACA185 to descend to FL 360, without providing any information as to the reason for the descent. As ACA185 acknowledged the descent instruction, the TCAS on ACA185 and NWA26 issued a traffic alert to the flight crews at 1004:13.

At 1004:17, the controller instructed NWA26 to turn left 30°, without providing any information as to the reason for the turn. As NWA26 acknowledged the turn instruction, the TCAS issued an RA at 1004:26 for NWA26 to climb and ACA185 to descend.

At 1004:31, unaware of the TCAS RA, the controller instructed ACA185 to turn left 30°, without providing any information as to the reason for the turn. ACA185 acknowledged the turn instruction at 1004:32, and stated that their TCAS displayed the traffic and that they had visual contact with the other aircraft, but did not report the TCAS RA descent. Controllers routinely hear crews acknowledging traffic as displayed on TCAS, and the Thompson controller understood the ACA185 TCAS comment to mean that they could see the traffic on TCAS and not that they had received an RA.

Radar data showed that NWA26 responded to the controller's turn instruction at 1004:32, and ACA185, at 1004:46. The NWA26 crew members advised the controller that they had visual contact with the traffic below, but did not report the TCAS RA climb.

The ATC conflict alert system terminated the traffic alert at 1004:38, and did not issue a conflict alert. The TCAS issued a "clear of conflict" message at 1005:04 while the crew members of ACA185 were advising the controller that they were returning to FL 360 and that they had executed a TCAS manoeuvre. See Appendix B for a summary of the radar data analysis showing vertical and horizontal spacing during the TCAS RA manoeuvre.

During the RA manoeuvre, the controller re-evaluated the separation plan for ACA185 and DLH456, and, at 1005:10, cleared ACA185 to maintain FL 360. In response to the TCAS "clear of conflict" advisory, NWA26 returned to FL 370 at 1005:34, and ACA185 returned to FL 360 at 1005:54.

The controller subsequently assigned a route change for NWA26 at FL 370, and maintained required lateral separation between ACA185 and DLH456, both at FL 360, by instructing the flights to make speed and track changes.

The controller did not think a loss of separation had occurred, and continued working in the Thompson sector until relieved by another controller at 1028. The controller then reported the incident to the Shield specialty supervisor, and following initial investigation, was removed from duty.

Safety Alerts and Imperative Phraseology

Section 507.1 of the ATC MANOPS instructs controllers to "issue a safety alert to an aircraft if you are aware the aircraft is at an altitude which . . . places it in unsafe proximity to . . . another aircraft." The ATC MANOPS provides recommended phraseology for safety alerts, including "turn left/right (number) degrees immediately to avoid traffic at (bearing by clock-reference and distance)." However, safety alert phraseology is not intended to resolve conflicts between two aircraft both of which are under the control of the same air traffic controller.

In 2004, NAV CANADA issued Air Traffic Services Bulletin NP8493 titled *Imperative Phraseology* in response to several TSB investigation reports[2] that noted the importance of standard phraseology that includes both corrective action and traffic information to all involved aircraft in the event of a loss of separation occurrence. This bulletin emphasized the importance of controllers using appropriate imperative phraseology when faced with incidents where action by the pilot is required immediately. The bulletin provided recommended imperative phraseology, including "TURN LEFT/RIGHT (number) DEGREES IMMEDIATELY TO AVOID TRAFFIC AT (bearing by clock-reference and distance)."

Traffic Alert and Collision-Avoidance System Resolution Advisory Altitude Excursions and Controller Notification

Canadian Aviation Regulations (CARs) permit flight crews to deviate from ATC clearances or instructions to the extent necessary to carry out a collision-avoidance manoeuvre, where the manoeuvre is carried out in accordance with an RA generated by the TCAS. When such a manoeuvre is carried out, the CARs require the flight crew to inform ATC about the clearance deviation as soon as possible after initiating the collision-avoidance manoeuvre.

Issuance of an RA is considered to be an abnormal situation requiring prompt decisions and action by the flight crew, including notifying ATC when deviating from cleared flight paths. This notification improves controller situational awareness and is a controller's only information that a TCAS RA collision-avoidance manoeuvre is occurring. The controller needs to be aware of the manoeuvre so that he or she does not issue instructions for climb or descent contradicting the TCAS–coordinated RA.[3]

Transport Canada provides policy and operational guidance regarding the use of TCAS and pilot/controller actions,[4] and advises flight crews to use the phrase "TCAS CLIMB (or DESCENT)" to notify ATC of flight path clearance deviations made to comply with a TCAS RA. Transport Canada requires the same standards for use of TCAS as those specified in Federal Aviation Administration (FAA) Advisory Circular 120-55A, as amended, and refers operators to this document. The current amendment, 120-55B, provides the following guidance:

- Pilot Responsibilities . . . If a TCAS RA response requires deviation from an ATC clearance . . . In responding to a TCAS RA that directs a deviation from assigned altitude, communicate with ATC as soon as practicable after responding to the RA.

- TCAS Event Reporting . . . Upon query from ATC, or after a deviation from an ATC clearance, make radio communications as appropriate to report a response to a TCAS advisory.

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2 TSB investigation reportsA02C0079, A01C0155, A01P0111, and A00H0002 refer.

3 German Federal Bureau of Aircraft Accidents, Investigation Report AX001-1-2/02, May 2004, B757-200 and TU154M Collision on 01 July 2002 near Ueberlingen, Germany.

4 TP 14371, *Aeronautical Information Manual* (AIM), Section 12.15.

- Appendix 5 Phraseology for TCAS Events . . . When a flight crew receives a TCAS RA to either climb or descend from their assigned altitude, or the RA otherwise affects their ATC clearance or their pending manoeuvre or manoeuvre in progress, the crew should inform ATC when beginning the excursion from clearance or as soon as workload allows . . . NOTE: Communication is not required if the pilot is able to satisfy the RA guidance and maintain the appropriate ATC clearance.

- Delayed crew response or reluctance of a flight crew to adjust the aircraft's flight path as advised by TCAS due to Air Traffic Control (ATC) clearance provisions . . . could significantly decrease or negate the protection afforded by TCAS.

- Excursions from assigned altitude, when responding to an RA, typically should be no more than 300 to 500 feet to satisfy the conflict.

- Appendix 5 suggests the phrase "TCAS Climb/Descent" be used by flight crews to notify ATC of a TCAS RA manoeuvre.

The Air Canada aircraft operating manual required the crew to notify ATC of the RA manoeuvre using the phrase "TCAS DESCENT." Northwest Airlines policy makes it mandatory for pilots to comply with a TCAS RA, which supersedes any ATC instructions, and to notify ATC of the RA manoeuvre as soon as possible. Northwest Airlines does not specify phrases to be used because the TCAS II system commands several different types of resolution advisories that include reversals, such as an RA to climb changing to an RA to descend.

Controller guidance in ATC MANOPS requires a controller to provide relevant traffic information and collision-avoidance advice when a controller is advised by an aircraft that it is responding to a TCAS RA. ATC MANOPS additionally states "do not issue control instructions that would contradict an aircraft's resolution advisory or warning" and "if an aircraft manoeuvres outside the limits of its clearance, the controller is not responsible for separation between it and other aircraft, airspace protected for other aircraft, terrain, or obstructions."

The TSB has investigated at least one other occurrence in which flight crews did not correctly notify ATC they were deviating from their clearances while executing a TCAS collision-avoidance manoeuvre (TSB investigation report A00H0002).

Human Performance

Confirmation bias is a human tendency to seek information that will confirm what a person already believes to be true. Information that is inconsistent with the chosen hypothesis is then ignored or discounted, while attention is only given to information that supports the hypothesis.[5]

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[5] Transportation Safety Board of Canada, *An Integrated Process for Investigating Human Factors*, February 1998.

Analysis

Because of an invalid altitude for NWA26 at 1004:46, the investigation could not determine whether less than the required separation existed between NWA26 and ACA185 (5 nm lateral or 1000 feet vertical). However, safety was not assured when ACA185 was cleared to climb to FL380 without the assurance that the required separation with NWA26 would be maintained. As a result, TCAS RAs were annunciated to both aircraft crews and a conflict alert system traffic alert was displayed on the controller's ISiT. This situation falls within the ATC MANOPS definition of a loss of separation.

Losses of separation and short-term conflict alert warnings are unusual occurrences and require an immediate assessment of the particular situation and use of clear and concise phraseology adapted to the circumstances. Additionally, it is imperative that pilots inform ATC immediately if responding to an RA in clear and concise phraseology so that ATC will refrain from issuing contradictory instructions or clearances. These issues will be discussed below.

Controller Personal Practices

ATC MANOPS specifies separation standards to be maintained and phraseology to be used, but does not specify procedures to follow in assessing a control plan. Consequently, controllers adapted personal practices to identify traffic conflicts and develop separation plans, and the personal practices varied between controllers. The Thompson controller's personal practice for a climbing aircraft was to visually scan the ISiT and flight progress strips, but did not make use of ISiT tools such as RBL or PTL ALL to determine whether any traffic presented a conflict for the climb of ACA185.

Separation Planning and Human Performance

As early as 0939, the controller planned to maintain separation between DLH456 and ACA185 by having ACA185 climb from FL 360 to FL 380. The instruction for ACA185 to climb to FL 380 was issued about 5 minutes (30 miles) after NWA12D cleared the track of ACA185 and before NWA26 arrived at the crossing point with ACA185. As NWA12D cleared the track of ACA185, the controller confirmed to himself that there was no conflict with NWA12D. The controller scanned the flight progress strips and radar display, but he only saw that he had the required spacing between ACA185 and NWA12D. The controller did not perceive the conflict between ACA185 climbing to FL 380 and NWA26 at FL 370.

The 23 minutes available to the controller before the separation plan for ACA185 and DLH456 was executed should have permitted a thorough assessment of information displayed on the ISiT and flight progress strips, including information about NWA26. However, the controller's mental plan was reinforced by the emphasized information before him: red aircraft identification of DLH456 and ACA185, blue range bearing lines on DLH456 and ACA185, and red "W"s on the DLH456 and ACA185 flight progress strips. In comparison, information regarding NWA26 was displayed without emphasis on both the ISiT and flight progress strip, and was not required to be emphasized because NWA26 was at FL 370 and did not conflict with either DLH456 or ACA185 at FL 360.

Confirmation bias likely reduced the controller's ability to perceive important information about NWA26 undermining the plan to separate ACA185 and DLH456. Use of the ISiT RBL or PTL ALL functions could have helped the controller overcome confirmation bias and identify NWA26 as a conflict for the planned climb of ACA185. The capabilities of ISiT tools to help the controller overcome confirmation bias were negated because procedures did not require their use and the controller did not use them between ACA185 and NWA26.

Execution and Monitoring of Separation Plan

The controller did not identify that NWA26 would conflict with the climb of ACA185. Consequently, there was no separation plan for NWA26 and ACA185. This analysis will examine the controller's separation plan between ACA185 and DLH456.

The controller was working alone in the Thompson sector, handling both the radar and data positions. Working alone placed an increased demand on the controller to properly prioritize his actions and ensure that the required level of attention was focused on the immediate task. When another sector called with estimates, the controller chose to process the incoming estimates rather than delaying this data transaction until after ACA185 had completed its climb to FL 380. Consequently, the time available to the controller to monitor the execution of the separation plan between ACA185 and DLH456 was reduced. The time available was further reduced because the controller chose to search for and retrieve a flight progress strip that had been sent to the incorrect sector. This had the effect of increasing the time the aircraft (ACA185 and NWA26) were at risk of collision before the controller identified the conflict and initiated corrective action.

Controller Collision-Avoidance Instructions

The controller took immediate action and issued instructions to maintain separation of the aircraft once the conflict between ACA185 and NWA26 was recognized. However, the instructions did not use either safety alert phraseology or imperative phraseology to emphasize the urgent nature of the instructions or the reason for them.

ACA185 was instructed in a non-urgent manner to execute a flight level change from climb to FL 380 to descent to FL 360. This instruction was not compelling enough to trigger an immediate response; consequently, ACA185 had not yet commenced descent when the TCAS issued the RA to both flight crews 16 seconds after the descent instruction. The TCAS RA was a more compelling stimulus for the flight crews, as six seconds after receiving the RA, both ACA185 and NWA26 had commenced their collision-avoidance manoeuvres. Because the controller did not use imperative phraseology or safety alert phraseology with associated traffic information, the time needed to achieve the controller's intentions was increased and this increased the time the two aircraft were at risk of collision.

Controller Notification of Traffic Alert and Collision-Avoidance System Collision-Avoidance Manoeuvre

The CARs require flight crews to inform ATC about clearance deviations as soon as possible after initiating the collision-avoidance manoeuvre. However, guidance in the AIM and FAA AC120-55B for phraseology to do so is a recommended practice rather than a standard. Additionally, the characteristics of TCAS are such that an RA–commanded manoeuvre can be reversed, such as a climb RA changing to a descent RA. Consequently, company guidance provided to the flight crews regarding controller notification varied between Air Canada and Northwest Airlines. While Air Canada required crews to use the phrase "TCAS DESCENT/CLIMB," Northwest Airlines required only that crews notify controllers but did not require the use of specific phrases.

In this occurrence, both flight crews did mention TCAS, but neither crew used the recommended phrase to notify the controller once it was known that they would deviate from their assigned altitude clearance. Consequently, the controller was not aware that they were deviating from their clearances while executing a TCAS collision-avoidance manoeuvre.

The controller did not issue any instructions contradicting the TCAS RA. However, because the flight crews did not notify the controller of collision-avoidance manoeuvres that would result in a deviation from the ATC–cleared altitude with the correct phraseology, the controller was unaware of the TCAS collision-avoidance manoeuvre and could have issued contradicting instructions.

Findings as to Causes and Contributing Factors

1. Before executing the separation plan for ACA185 and DLH456, the controller did not identify that it would result in a conflict between ACA185 and NWA26.

2. The time available to monitor the execution of the separation plan was reduced because the controller, who was working alone, chose to accept incoming estimates and search for and retrieve a flight progress strip sent to an incorrect sector. This increased the time the aircraft were at risk of collision before the controller identified the conflict and initiated corrective action.

3. Confirmation bias likely reduced the controller's ability to perceive displayed information about NWA26 that negated the controller's separation plan between ACA185 and DLH456.

4. The capabilities of integrated situational display system (ISiT) tools to help the controller overcome confirmation bias were negated because procedures did not require their use and the controller did not use them between ACA185 and NWA26.

Findings as to Risk

1. The time needed to achieve intended flight crew response increases when controllers do not use either imperative phraseology or safety alert phraseology with associated traffic information. This increases the time that aircraft are at risk of collision.

2. When flight crews do not notify controllers, with the recommended phraseology, about collision-avoidance manoeuvres that would result in a deviation from the air traffic control clearances, controllers may issue contradicting instructions.

Other Finding

1. Both flights deviated from assigned altitudes by 600 feet during the collision-avoidance manoeuvre. These altitude excursions were close to expected norms.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 07 February 2008.

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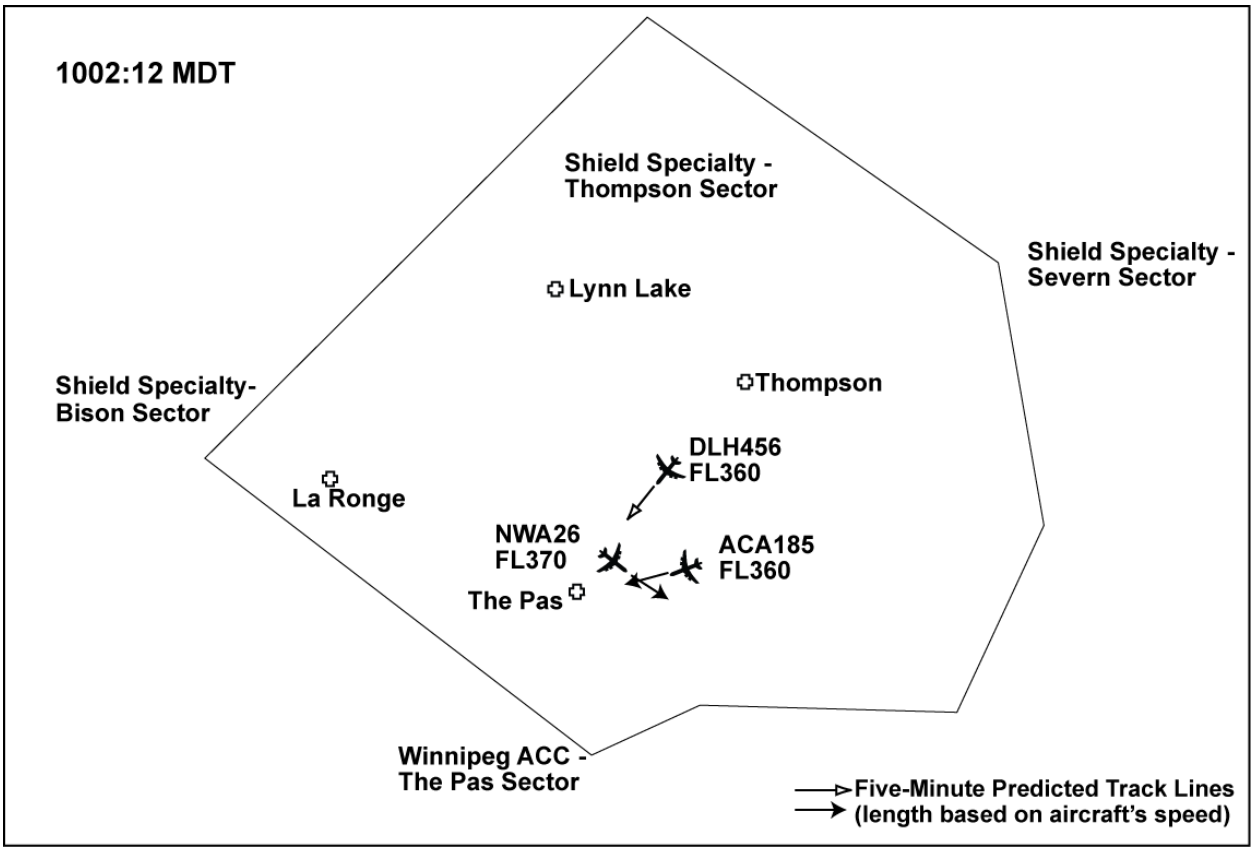
Appendix A – Thompson Sector Boundaries



Appendix B – Traffic Alert and Collision-Avoidance System Resolution Advisory Manoeuvre – Radar Data Analysis

Time (mountain daylight time)	ACA185 Flight Level	NWA26 Flight Level	Vertical Spacing (feet)	Horizontal spacing (nm)
1004:03	367	370	300	14.9
1004:08	367	370	300	13.76
1004:12	367	370	300	12.59
1004:17	367	370	300	11.38
1004:22	367	370	300	10.24
1004:27	367	370	300	9.27
1004:32	367	370	300	7.9
1004:36	366	372	600	6.65
1004:41	365	373	800	5.46
1004:46	363	Missing	Missing	4.2
1004:51	361	376	1500	2.94
1004:56	358	376	1800	1.91
1005:01	355	376	2100	0.96
1005:05	354	Missing	Missing	0.7
1005:10	354	375	2100	1.68
1005:15	354	374	2000	2.71
1005:20	356	373	1700	3.76
1005:25	357	372	1500	4.77
1005:30	357	371	1400	5.99
1005:34	358	370	1200	7.22
1005:39	359	369	1000	8.25
1005:44	359	369	1000	9.46
1005:49	359	368	900	10.49
1005:54	360	369	900	11.75