

Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada

**AVIATION INVESTIGATION REPORT  
A12O0030**



**LOSS OF SEPARATION AND RISK OF COLLISION**

**NAV CANADA – TORONTO AREA CONTROL CENTRE  
LONDON, ONTARIO, 20 NM NW  
08 MARCH 2012**

**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 and Risk of Collision

NAV CANADA – Toronto Area Control Centre  
London, Ontario, 20 nm NW  
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Report Number A12O0030

### *Summary*

A Cessna Citation X (registration N217AL, serial number 750-0217), operated by XO Jet, was on an instrument flight rules flight from Norman Y. Mineta San Jose International Airport in San Jose, California, to Laurence G. Hanscom Field Airport in Bedford, Massachusetts. The aircraft was cleared by Oakland Air Route Traffic Control Center to maintain flight level 430, an altitude normally reserved for westbound aircraft. A Gulfstream V (registration N128GV, serial number 665), operated by Executive Jet Management, was on a westbound instrument flight rules flight from Bradley International Airport in Windsor Locks, Connecticut, to San Francisco International Airport in San Francisco, California, and was also cleared to maintain flight level 430. The routing for both aircraft included the portion of J16 airway between Peck VOR (very high frequency omnidirectional radio range) and London VOR on reciprocal tracks. At 1342 Eastern Standard Time, the 2 aircraft responded to traffic alert and collision-avoidance system resolution advisories, and passed each other separated by 1 nautical mile laterally and 900 feet vertically. No damage or injuries occurred.

*Ce rapport est également disponible en français.*

## Factual Information

### Background

Flights proceeding along J16 Airway are provided with air traffic services from several locations. The segment of J16 beginning 17 nautical miles (nm) east of Peck (ECK) very high frequency omnidirectional radio range (VOR), continuing to 18 nm west of Buffalo (BUF) VOR at flight level (FL) 430, is controlled by the west high specialty of the Toronto Area Control Centre (CZYZ ACC, hereinafter referred to as CZYZ). The west high specialty is divided into several sectors. At the time of the occurrence, this segment was being controlled by Oakville sector, which was staffed by 2 controllers. One controller occupied the data position, focused mainly on coordination and data management, and the other controller occupied the radar position, focused primarily on communications and active control.

The portions of J16 on either end of this segment are controlled by the Cleveland Air Route Traffic Control Center (KZOB ARTCC, hereinafter referred to as KZOB), Gamble sector to the west, and Stueben sector to the east (Figure 1). At the time of the occurrence, both Gamble and Stueben sectors were staffed by 2 controllers.

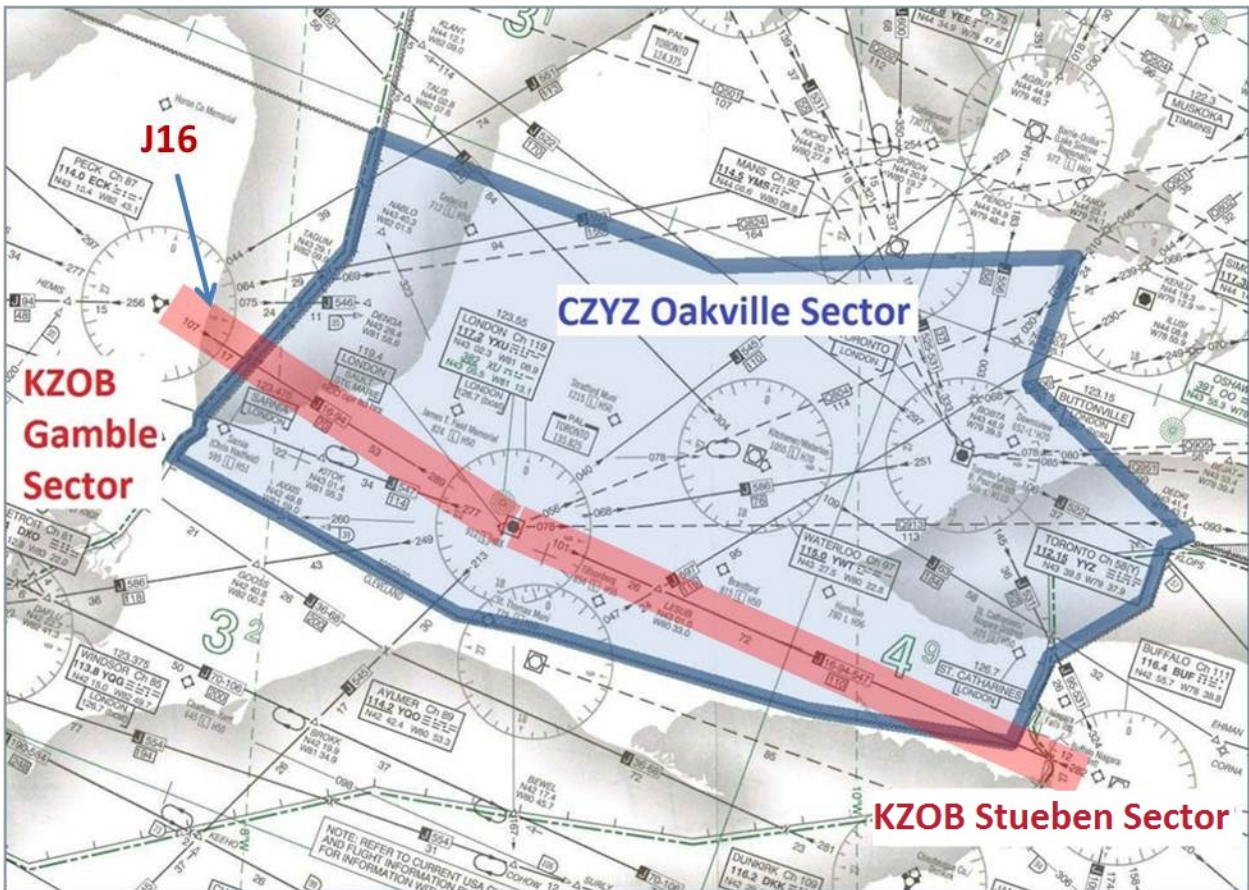


Figure 1. Responsibility for control at FL 430 at the time of the occurrence

## *Timeline*

- 1336:47 <sup>1</sup> The Gamble sector data controller contacted the Oakville sector radar controller to hand off control of N217AL, stating that the aircraft was now 10 nm west of ECK at FL 430. This was the first communication between Gamble and Oakville with regard to N217AL, and, although required by the inter-unit agreement, there was no mention of this eastbound FL being an inappropriate altitude for direction of flight (IAFDF).
- 1337:33 Gamble sector attempted to contact N217AL to issue a frequency change, but was unsuccessful. Twelve seconds later, Gamble sector issued the instruction again, informing N217AL to contact Toronto Centre on frequency 134.92. N217AL acknowledged this instruction overhead ECK VOR.
- 1338:30 The data controller in Oakville sector was relieved by another controller. The sector was considered by the controllers as not very busy, and a handover briefing <sup>2</sup> was not completed. The new controller began organizing the data board and formulating a mental traffic picture.
- 1339:55 N128GV was overhead YXU VOR, having previously established communications with Toronto Centre.
- 1340:54 The controller occupying the radar position in Oakville was relieved by another controller. A handover briefing was completed, and both N217AL and N128GV were pointed out at FL 430; however, there was no mention that N217AL's altitude was an IAFDF, or that the 2 aircraft were in conflict (Figure 2).
- 1341:30 The Oakville data controller notified the radar controller that there was a flight-progress strip for an inbound aircraft (N217AL) at an IAFDF.
- 1341:39 A traffic alert was displayed on the Oakville radar controller's monitor. The 2 aircraft were now 20 nm apart and closing at a rate of 980 knots, or 16<sup>1</sup>/<sub>3</sub> nm per minute.
- 1341:55 The Oakville radar controller attempted to contact N217AL and instruct the pilot to descend now to FL 410. The instruction was not acknowledged.
- 1342:03 The Oakville radar controller attempted again to contact N217AL, unsuccessfully. The 2 aircraft were now less than 15 nm apart.
- 1342:04 Flight crews in both aircraft received traffic alert and collision-avoidance system (TCAS) traffic advisory (TA) warnings.

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<sup>1</sup> All times are Eastern Standard Time (Coordinated Universal Time minus 5 hours).

<sup>2</sup> The term "handover briefing" is used in lieu of the official term, "Transfer of Position Responsibility Briefing," referred to in the NAV CANADA *Air Traffic Control Manual of Operations*.

- 1342:11 The Oakville radar controller instructed the crew of N128GV to turn 25 degrees to the right, and alerted them to the traffic directly in front of them. The instruction was acknowledged by N128GV.
- 1342:17 Flight crews in both aircraft received TCAS resolution advisory (RA) warnings, which instructed N217AL to descend and N128GV to climb. The aircraft were now less than 10 nm apart. The flight crews began to react to these alarms.
- 1342:18 The Oakville radar controller again instructed N217AL to descend now to FL 410. Due to alarms in the cockpit, the crew did not clearly hear this instruction, and decided to verify with the controller that the call was for them. The controller instructed them to descend immediately.
- 1342:34 N217AL acknowledged the immediate-descent instruction. The aircraft were now 6 nm apart.
- 1342:36 A conflict alert was displayed on the Oakville radar controller's monitor. The aircraft were now 5 nm apart, and had begun to alter their vertical flight paths.
- 1342:40 The Oakville radar controller instructed N128GV to start a climb. The crew of N128GV acknowledged this instruction, and informed the controller that they were already responding to a TCAS RA. The aircraft were now less than 3 nm apart.
- 1342:52 N217AL and N128GV crossed paths, separated by 900 feet vertically and 1 nm laterally. The minimum required separation is 2000 feet vertically, or 5 nm laterally.

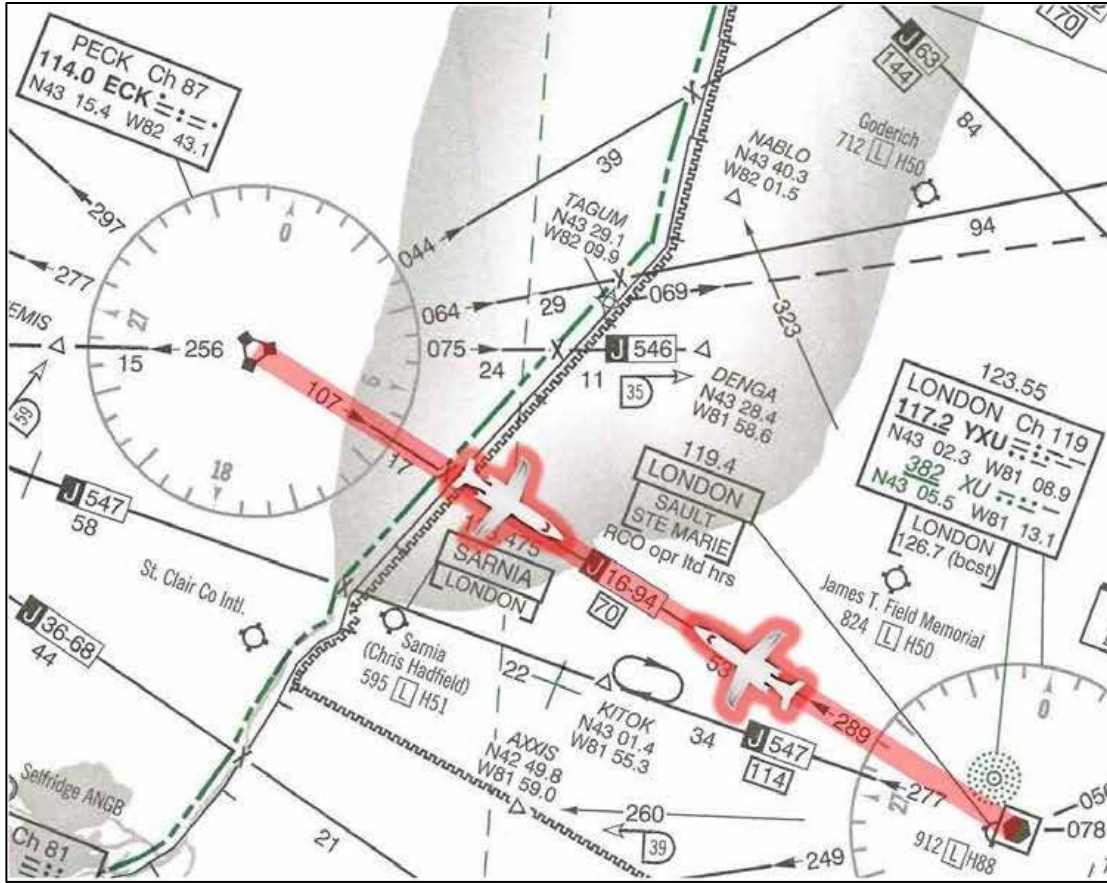


Figure 2. Two aircraft on reciprocal tracks on J16 Airway

## Flight Crews

Records indicate that both flight crews were certified and qualified for the flight in accordance with existing regulations.

## Aircraft

Records indicate that both aircraft were certified, equipped, and maintained in accordance with existing regulations and approved procedures.

Both aircraft were equipped with TCAS. TCAS is an aircraft system that is based on secondary surveillance radar (SSR) transponder signals and that operates independently of ground-based equipment to provide advice to flight crew on potentially conflicting aircraft that are equipped with SSR transponders. Advice is provided on 2 levels: TAs and RAs. TAs inform the pilot of potential traffic conflicts, whereas RAs inform the pilot of an actual conflict and provide advice on manoeuvres to avoid collision. Both TAs and RAs provide visual and verbal alerts.

TCAS provides alerts based primarily on a calculation of time remaining to the closest point of approach (CPA). The result of this calculation is in seconds, and is referred to as Tau. The TCAS

sets alarm thresholds according to sensitivity levels that are generally based on altitude. The alarm thresholds above 20 000 feet above sea level are a Tau of 48 seconds for TAs, and 35 seconds for RAs.

The closure rate between N217AL and N128GV at the time of the occurrence was 980 knots. At that rate, TCAS would provide a TA when the aircraft are 13.1 nm apart, and an RA when they are 9.5 nm apart.

### *Air Traffic Controllers*

Records indicate that all of the air traffic controllers involved were certified and qualified for the operation in accordance with existing regulations.

Air traffic in this corridor is often amongst the busiest in Canada; however, at the time of the occurrence, traffic was considered light, and as a result, controller workload was assessed as light with limited complexity.

The controllers involved were well rested, and fatigue was not considered a factor in this occurrence.

Over the last several years, NAV CANADA has deployed a computerized, paperless flight-data tracking and position-updating system called CAATS (Canadian automated air traffic system). Each sector in CZZZ is equipped with a CAATS controller interface, which is referred to as CSiT (CAATS situation display).

The requirements of the CZZZ west high specialty radar and data positions are outlined in the NAV CANADA *West High Specialty Sector Operations Manual*. Listed as some of the radar controller's responsibilities are managing traffic flow through the sector, issuing instructions and clearances, and identifying and resolving conflicts. The list of responsibilities for the data position includes slotting flight-progress strips and checking for conflicts, entering and modifying CAATS information, and working in coordination with the radar position. Tasks such as passing estimates and modifying flight plans, which used to be the data position's responsibility, have primarily been taken over by CAATS. As a result, the task load and complexity of the data position during routine operations has been gradually reduced throughout the years, with associated advances in computer automation.

Research <sup>3</sup> has shown that, to the extent that current automation has the aim of allocating certain routine data-gathering and manipulation tasks to computers, leaving intact the controller's decision-making and planning duties, automation may not harm controller vigilance. However, if automation does encroach on these higher-order task functions, there is the attendant danger that vigilant monitoring may be negatively affected.

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<sup>3</sup> C.D. Wickens, A.S. Mavor, J.P. McGee, editors, Panel on Human Factors in Air Traffic Control Automation, in: *Flight to the Future: Human Factors in Air Traffic Control* (1997), page 129



## *Air Traffic Services Agreement*

There is a letter of agreement between KZOB and CZZY, dated 25 August 2005, which defines inter-facility responsibilities and coordination procedures. An addendum to the agreement, dated 22 March 2008, states the following in Section C:

### **C. VERBAL FLIGHT PLAN COORDINATION PROCEDURES**

C.1 At the time of radar hand off, the transferring facility shall verbally coordinate:

- C.1.1 Aircraft identification;
- C.1.2 Position – Current altitude;
- C.1.3 Assigned altitude; and
- C.1.4 Route of flight to the next fix in the flight plan.

C.2 The transferring facility is required to verbally coordinate for approval (APREQ) prior to the handoff when:

- C.2.1 Aircraft departing from airports less than 10 minutes flying time from the control boundary. The transferring facility shall coordinate, as soon as practical, to APREQ an altitude and, if necessary, pass flight plan or control information. Toronto area airports and CNZ3 are considered more than 10 minutes flying time;
- C.2.2 Aircraft are operating in block altitudes;
- C.2.3 A non-RVSM [*reduced vertical separation minimum*] exception flight is operating in RVSM airspace;
- C.2.4 Aircraft operating at altitudes inappropriate to direction of flight;
- C.2.5 Aircraft exiting KZOB/CZZY in the descent phase of flight not covered in the LOA [*letter of agreement*] by procedure shall have the altitude verbally coordinated;
- C.2.6 Formation flights.

The Gamble sector data controller who coordinated the handoff of N217AL to the Oakville sector radar controller believed that providing the altitude during the handoff was sufficient to cover the requirements of Section C.2.

### *Inappropriate Altitude for Direction of Flight*

*Canadian Aviation Regulations* (CARs) Part 602.34 requires instrument flight rules (IFR) aircraft to fly at the appropriate altitudes for direction of flight, unless cleared otherwise by air traffic control (ATC). This regulation is to prevent aircraft that are flying toward one another from being at the same altitude. FL 430 is an altitude normally assigned to westbound aircraft.



ATC rules and procedures differ somewhat between Canada and the United States with regard to IAFDF.

The United States air traffic controllers may assign an IAFDF when traffic prevents assignment of an appropriate altitude, as long as they have an agreement in place regarding such assignments with adjoining facilities. <sup>4</sup> KZOB has such an agreement in place with several adjoining facilities, including CZZY.

N217AL was cleared initially to an IAFDF by Oakland ARTCC for undetermined reasons.

The *Air Traffic Control Manual of Operations* (ATC MANOPS), which is followed by CZZY, is much more restrictive with regard to IAFDF operations. ATC may assign an IAFDF due to traffic when no alternate separation minima can be applied only if the aircraft will be cleared back to an appropriate altitude as soon as possible. If an IAFDF is assigned due to traffic, the controller must issue radar vectors or offset tracks to establish the aircraft at least 5 miles from the centerline of the airway. This procedure is intended to maintain controller involvement and provide an additional margin of safety while aircraft are operating on an IAFDF. In addition to the offset, controllers must instruct the aircraft to make position reports, and must identify the altitude as “wrong way” during estimates, hand-offs, and coordination.

To aid controllers in recognizing aircraft that are at an IAFDF, CAATS incorporates an automated wrong-way alerting function. The system is designed to recognize aircraft within a defined airspace that are travelling at an IAFDF for a defined period of time, and to display an alert to the controller. In sectors where aircraft routinely change altitudes and climb at slower rates, such as west high specialty in CZZY, the system can produce a significant number of false alarms due to the length of time that aircraft spend climbing through an IAFDF. Due to these false alarms, the automated alerting function in west high specialty is not enabled. Controllers do have the option of manually adding an IAFDF indicator on the CSiT; however, this option requires recognition by the controllers that the aircraft is at an IAFDF.

### *Board Management and Strip Marking*

NAV CANADA uses paper flight-progress strips to back up and augment its computerized flight-tracking systems. Guidelines on how to mark and organize these strips are detailed in ATC MANOPS.

As flights progress through different sectors, strips are automatically printed out; a strip is produced shortly before an aircraft arrives in a sector. The strip contains, among other information, the aircraft’s routing and altitude.

Controllers are instructed to write a red “W” on any portion of a strip if corrective action will be necessary. The “W” serves as a warning indicator to attract controller attention to potentially hazardous or critical situations, such as a conflict with another aircraft.

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<sup>4</sup> Federal Aviation Administration (FAA) Order JO 7110.65U, Air Traffic Organization Policy 4.5.3 a(2)

When an aircraft makes initial contact at the assigned cruising altitude, controllers are instructed to put a check mark next to the altitude, to serve as a reminder that contact has been made, and to verify that the aircraft is at the assigned altitude.

If an IAFDF is assigned, controllers are instructed to circle the altitude portion of the strip with a red pen.

Once the strips have been slotted into their holders and placed on the flight-progress board, they are organized in a fashion so as to better give the controller a mental picture of the traffic, and to assist in identifying potential conflicts. If the controller determines that a situation requires investigation or further action, the controller is instructed to cock <sup>5</sup> the strip to make it visually stand out from the rest.

The strip for N217AL, which was assigned an IAFDF, arrived in the printer 30 minutes before the controller in the Oakville data position was relieved. It could not be determined whether, at the time of relief, the strip was in the printer or on the board. However, if it was on the board, it wasn't marked in any fashion or cocked. The relieving data controller noticed this strip shortly after taking over, circled the IAFDF altitude, and cocked it for further investigation. The data controller then noticed that there was no check mark next to the altitude. Assuming the aircraft was not yet in the sector, the data controller notified the radar controller, who had been in position only a minute, that the aircraft was coming. As the data controller was still formulating a mental picture, a conflict was not yet identified, and as such, a "W" was not written on the strip.

A few seconds later, a traffic alert was displayed on the radar controller's screen.

### *Position Relief and Checklist*

Controllers are rotated in and out of position during their shifts to keep them adequately rested and to maintain their performance. In a specialty such as west high at CZZZ, a controller returning from break will relieve the controller who is most in need of a break, regardless of position. It is not uncommon to have 2 controllers come off of a break at the same time and relieve 2 controllers working the same sector.

ATC MANOPS requires that a verbal handover briefing be completed when one controller relieves another. This briefing must include the use of a transfer-of-position checklist and shall be recorded. The relieved controller is instructed to remain for monitoring purposes, and to assist the relieving controller in becoming familiarized with the position, for a period appropriate to the traffic volume and complexity.

In this occurrence, when the relieving data controller assumed control, there were no strips on the board that were cocked or that contained red circles or a W. The handover briefing was not completed or recorded. The relieved data controller assessed the traffic as light, and as such, did not remain for monitoring purposes.

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<sup>5</sup> The physical misalignment of a plastic strip holder on a board of otherwise uniformly organized strips.

The transfer-of-position checklist contains a line regarding potential conflicts. However, as the relieved radar controller had not yet identified the potential conflict between N217AL and N128GV, this information was not passed on to the relieving radar controller. The relieved radar controller did remain and provide monitoring after the briefing.

## *Analysis*

The controllers and flight crew involved were certified and qualified for the operation in accordance with existing regulations. Fatigue was not considered a contributing factor. The analysis will therefore focus on the series of events, conditions and underlying factors that led to the occurrence.

Due to the fact that there are fewer operational restrictions pertaining to inappropriate altitude for direction of flight (IAFDF) in the United States versus Canada, the Cleveland Air Route Traffic Control Centre (KZOB) controllers may not have considered N217AL's altitude assignment to be as significant as their Canadian counterparts considered it to be. The KZOB controller believed that inclusion of altitude during the hand-off was sufficient to meet the requirement to request approval (APREQ) before hand-off. As a result, the Oakville radar controller who received the hand-off did not immediately recognize that the flight was at an IAFDF.

The reduced workload caused by the increase in automation of the data position, or by the level of traffic leading up to this occurrence, may have had the negative effect of reducing controller vigilance. Possibly due to a lack of vigilance, the original data controller had either not noticed that the strip for N217AL was in the printer, or had placed it on the board without marking or cocking it when handing the position over to the relieving data controller without a handover briefing.

The crew of N217AL, for unknown reasons, did not contact the west high specialty of the Toronto Area Control Centre (CZYZ) when instructed to by KZOB. The call would normally have reminded the controller in CZYZ of the aircraft's position and prompted the placing of a check mark next to the altitude section of the flight-progress strip. Had the strip been marked at this time, the controllers would have had a greater opportunity to identify the conflict.

The relieving data controller had just taken position when the controller in the radar position was relieved. Possibly due to an incomplete handover briefing, the data controller was still organizing the board and gathering a mental picture of the traffic when the incident occurred. As a result, despite having recognized that there was an aircraft at an IAFDF, the data controller was not yet in a position to recognize the pending conflict and notify the new radar controller of it.

During the handover briefing between the 2 radar controllers, the relieved controller was not aware that N217AL was at an IAFDF, possibly due to the missed approval request and the absence of a circled strip on the board. Given the fact that aircraft on reciprocal tracks are customarily at different altitudes, and lacking the knowledge that one was at an IAFDF, it would not be readily apparent that they were in conflict. As a result, the relieving controller was not initially aware of the pending conflict.

The Canadian automated air traffic system situation display (CSiT) did not display an IAFDF alert, due to the fact that this function was disabled. This modification had been made in an effort to reduce false warnings, and resulted in a missed opportunity to assist the controller in

recognizing the conflict. The manual IAFDF indicator was not used, as the aircraft was not yet recognized to be at an IAFDF.

The traffic and conflict alerts on the CSiT worked as intended, and may have reduced the severity of the conflict had the controller been able to establish contact with N217AL on the initial call. It could not be determined why these calls were not acknowledged. After 2 attempts, the controller switched attention to N128GV, and successfully contacted the crew to issue turn instructions for separation and advise them of the traffic. The controller again tried and succeeded in contacting N217AL to issue immediate-descent instructions.

The traffic alert and collision-avoidance system (TCAS) aboard both aircraft functioned as designed; it alerted the flight crews to the risk of collision, and provided them with resolution advice.

## *Findings*

### *Findings as to Causes and Contributing Factors*

1. After being cleared to an inappropriate altitude for direction of flight, the aircraft was not re-cleared to an altitude appropriate for direction of flight at any time before entering the airspace of the west high specialty of the Toronto Area Control Centre.
2. The agreement between the west high specialty of the Toronto Area Control Centre and the Cleveland Air Route Traffic Control Centre, detailing approval requests for aircraft at an inappropriate altitude for direction of flight, was not followed.
3. The flight-progress strip for N217AL was not marked or cocked when the position was handed over to the relieving data controller.
4. The relieved radar controller did not recognize N217AL as being an aircraft at an inappropriate altitude for direction of flight on hand-off from the Cleveland Air Route Traffic Control Centre, and did not identify the conflict with N128GV. As the conflict was unknown, it was not communicated to the relieving radar controller.
5. The Canadian automated air traffic system situation display alert for an aircraft at an inappropriate altitude for direction of flight was disabled, and therefore did not alert the radar controller.
6. Following air-traffic-control intervention and crew response to the traffic alert and collision-avoidance system, the two aircraft came within 900 feet vertically and 1 nautical mile laterally of one another.

### *Findings as to Risk*

1. When the radar controllers and data controllers are both relieved in a very short time span, the possibility that one could provide effective oversight or assistance to the other in the initial moments following relief is limited.
2. When a controller is relieved and no handover briefing is conducted, there is an increased risk that aircraft operating at an inappropriate altitude for direction of flight will go unnoticed.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 April 2013. It was officially released on 18 July 2013.*

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*has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.*