Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

RISK OF COLLISION

BETWEEN
DELTA AIR LINES LOCKHEED L1011 N740DA
AND
BRITISH AIRWAYS BOEING 747 G-AWNH
NORTH ATLANTIC
08 MARCH 1995

REPORT NUMBER A95A0046

Canada

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

INDEPENDENCE

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.

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Aviation Occurrence Report

Risk of Collision

Between Delta Air Lines Lockheed L1011 N740DA and British Airways Boeing 747 G-AWNH North Atlantic 08 March 1995

Report Number A95A0046

Synopsis

British Airways flight 92 X-ray (BAW92X), a Boeing 747, was flying eastbound to London, England, along North Atlantic Track (NAT) Bravo at flight level 330 (FL330). At 1926 Coordinated Universal Time (UTC), the flight crew of BAW92X reported over St. Anthony, Newfoundland, with an estimate of 1950 UTC for the geographic fix of 53°00'N latitude, 50°00'W longitude (50 West); then, as instructed, they left the Gander Area Control Centre (ACC) frequency.

Delta Air Lines flight 49 (DAL49), a Lockheed L1011, was flying westbound on NAT Bravo to Cincinnati, Ohio, also at FL330. At 1936 UTC, DAL49 passed by 50 West. The flight crew contacted the Gander ACC at 1942 UTC, at which time they requested and received a clearance to climb to FL350. At approximately 1944 UTC, 225 nautical miles northeast of Gander, DAL49 passed about 1,800 feet above and one mile south of BAW92X, where the required separation was 2,000 feet vertically. There were no injuries to crew or passengers.

The Board determined that the controllers involved in this occurrence did not detect the traffic conflict between DAL49 and BAW92X prior to the risk of collision. Contributing to this occurrence were the controllers' loss of situational awareness created by complacency and a lack of vigilance during a period of low-traffic activity.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

At 1926 Coordinated Universal Time (UTC)[1], British Airways flight 92 X-ray (BAW92X)[2], a Boeing 747, passed over St. Anthony, Newfoundland (NFLD), flying at flight level 330 (FL330) eastbound to London, England, along North Atlantic Track (NAT) Bravo. The flight crew called Gander Area Control Centre (ACC) with their position report and gave an estimate of 1950 for the geographic fix 53°00'N latitude, 50°00'W longitude (50 West). Gander ACC acknowledged the estimate and, at 1926:35, instructed the flight crew to change to another frequency.

Delta Air Lines flight 49 (DAL49), a Lockheed L1011, passed over 50 West at 1936, flying westbound at FL330 along NAT Bravo to Cincinnati, Ohio. At 1942, the flight crew of DAL49 contacted Gander ACC for the first time. The flight crew requested and received a clearance to climb to FL350.

As DAL49's first officer entered the new altitude into the aircraft's vertical navigation computer, he observed conflicting opposite-direction traffic at 30 miles on the Traffic Alert and Collision Avoidance System (TCAS). The crew expedited the climb in order to avoid the conflicting traffic.

DAL49 passed about 1,800 feet above and one mile south of BAW92X, where the required separation was 2,000 feet vertically. The two aircraft had been closing at a combined speed of 980 knots, and at 30 miles were less than two minutes apart. The occurrence took place at 52°25'N, 52°40'W at approximately 1944, during daylight hours. (See Appendix A.)

1.2 Injuries to Persons

1.2.1 Delta Air Lines Lockheed L1011 N740DA

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	14	247	-	261

1 All times are Coordinated Universal Time (UTC) unless otherwise noted.

2 See Glossary for all abbreviations and acronyms.

Total	14	247	-	261

1.2.2 *British Airways Boeing 747 G-AWNH*

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	19	192	-	211
Total	19	192	-	211

1.3 *Damage to Aircraft*

There was no damage to either aircraft.

1.4 *Other Damage*

None.

1.5 *Personnel Information*

1.5.1 *Air Traffic Controller Information*

Controller Position	Oceanic Planner	High-Level Domestic
Age	43	30
Licence	IFR	IFR
Medical Expiry Date	01 Aug 95	01 Feb 96
Experience - as a Controller - as an IFR Controller - in Present Unit	 16 yr 16 yr 16 yr	 5 yr 5 yr 5 yr
Hours on Duty Prior to Occurrence	7	8

Hours Off Duty Prior to Work Period	9	8

Controller Position	High-Level Domestic OJI	High-Level Domestic Trainee
Age	43	24
Licence	IFR	IFR
Medical Expiry Date	01 Feb 96	01 Jun 96
Experience		
- as a Controller	12 yr	1 yr
- as an IFR Controller	12 yr	1 yr
- in Present Unit	12 yr	1 yr
Hours on Duty Prior to Occurrence	1	1
Hours Off Duty Prior to Work Period	12	48

Controller Position	Oceanic Controller
Age	26
Licence	IFR
Medical Expiry Date	01 Jun 95
Experience	
- as a Controller	3 yr
- as an IFR Controller	3 yr
- in Present Unit	3 yr
Hours on Duty Prior to Occurrence	1
Hours Off Duty Prior to Work Period	12

1.6 Aircraft Information

Not pertinent.

1.7 Meteorological Information

Both aircraft were operating under instrument flight rules (IFR) in visual meteorological conditions (VMC) at the time of the occurrence. The crew of DAL49 had visual contact with BAW92X as it passed below their aircraft.

1.8 Aids to Navigation

There were no reported discrepancies with the navigational aids being used by the aircraft involved in this occurrence. In addition, there were no reported discrepancies with the equipment being used by the Gander ACC controllers.

1.9 Communications

Communications between the Gander ACC and the aircraft were reported to be normal before, during, and after the occurrence.

1.10 North Atlantic Tracks

Air traffic control over the North Atlantic Ocean is handled primarily from Gander, Newfoundland, and Prestwick, Scotland. Primary responsibility for the planning function of the eastbound flow, which predominates at night between 2300 and 0500 UTC, rests with Gander, and for the westbound flow, which predominates during the daytime between 1000 and 2100 UTC, with Prestwick.

In order to regulate the flow during peak traffic periods, discrete tracks and altitudes are instituted. Conflict detection on these tracks over the ocean, east of 50° west longitude, up to 52° north latitude, is provided by the Gander automated air traffic system (GAATS). By using GAATS, the planner is alerted to any conflict with other oceanic traffic when an aircraft's flight plan is entered into the computer. Conflict detection in domestic airspace is the responsibility of the controller and is achieved by utilizing radar, flight progress strips, and pilot position reports.

This risk of collision took place in a small area of domestic airspace where there is no radar coverage; the controller must rely on information from the flight progress strips to provide separation.

It is possible for as many as 400 aircraft to transit the Gander Domestic airspace during the peak four hours of eastbound or westbound flow. During the changeover periods from day to night tracks, traffic volume and controller workload is considerably reduced. This daily change in traffic volume is generally consistent and is anticipated by the controllers.

1.11 Flight Progress Strips

The most basic form of controlling air traffic consists of monitoring a flight data board displaying flight progress strips, a paper strip for each aircraft's flight data. This data is updated manually by the controller from position reports received from aircraft. Flight progress strips are arranged in bays under fix designators corresponding to the geographic location of a navigational fix. A flight progress strip depicting an aircraft's route of flight and altitude is placed under the fix designator that will best indicate the geographic position of the aircraft so that potential traffic conflicts can be more easily recognized and accurately assessed.

In Gander ACC, flight progress strips for westbound aircraft are printed in red ink, while strips for eastbound aircraft are printed in black ink. For some time prior to the occurrence, there were only two aircraft flight progress strips under the St. Anthony fix designator. One strip was for the westbound DAL49 at FL330 and the other was for the eastbound BAW92X, also at FL330.

The *ATC Manual of Operations* (MANOPS), Appendix 2, explains flight progress strip marking for IFR operations. Section 1.1.8 describes the controller's on-going scan of the control data board as follows:

> Scan the control data board by performing the following actions:
>
> A. scan each bay individually rather than looking over the entire board;
>
> B. in each bay, check altitude boxes to verify vertical separation;
>
> C. if more than one aircraft is at the same altitude, check strips to ensure some other form of IFR separation exists;
>
> D. follow individual flights through the sector, checking for conflicting, converging or crossing track situations, consistency in altitude and estimate data, and for correct posting.

1.12 *Traffic Conflict Detection*

There were four opportunities for different controllers in Gander ACC to detect the traffic conflict developing between DAL49 and BAW92X.

Procedures, standards, guidelines, and checklists are available for the controllers to ensure the safe separation of aircraft. The separation standard that should have applied in this case was 2,000 feet vertically between the two aircraft. Staffing in the Gander ACC during the occurrence met unit standards.

1.12.1 *Oceanic Planner Controller*

The first opportunity to detect the conflict occurred when the oceanic planner initially received the requested altitude, FL330, for BAW92X. He coordinated this altitude with Prestwick centre and entered the information into GAATS. GAATS did not show a conflict between BAW92X and DAL49 because DAL49's estimated time of arrival (ETA) for 50 West was earlier than BAW92X's ETA for 50 West. The planner did not check with the Gander oceanic controller to determine if FL330 was okay for BAW92X because he saw that the oceanic controller was busy with a trainee. The planner checked the ocean data board himself and, although the data showed a conflict with DAL49 already at FL330, he did not detect the conflict. He returned to his position and the flight progress strip for BAW92X was produced at 1901.

1.12.2 *High-Level Domestic Controller*

A second opportunity to detect the conflict occurred when the Gander high-level domestic controller received the flight progress strip in black ink for BAW92X about 1845 and put it on the control data board under the St. Anthony fix designator along with the flight progress strip in red ink for DAL49. He did not detect the conflict during his routine scan of the control data board prior to being relieved at the sector.

1.12.3 *High-Level Domestic Controller Instructor and Trainee*

The third opportunity to detect the conflict occurred when the high-level domestic radar controller was relieved by a high-level domestic on-the-job instructor (OJI) and his trainee about 1915. The relieving controllers followed the standard Gander ACC procedure of first standing behind the position to observe the traffic. Next the relieving controllers were briefed, and a data board check was performed by the controller at the position. The briefing is designed to follow a written checklist and includes altitude reservations, separation problems to be resolved, conflicts, and immediate control actions. The relieving controller then sits at the sector position while the controller being relieved stands behind the position and observes until the relieving controller is acclimatized to the sector.

Controllers regard the sector briefing as common sense, and they report that the written checklists disappear from the control positions within a matter of days or weeks. In this case, the relieving controllers reported that they did observe the sector and get a briefing, and that the relieved controller did stand behind them for some time. The traffic conflict between BAW92X and DAL49, the only two data strips under the St. Anthony fix designator, was not detected at this time. The controllers reported that the sector briefing pointed out that most of the traffic was over the tracks in the southern airspace of the Gander area. The sector's radar was displaying mostly traffic on the tracks in the southern, rather than northern, part of the airspace.

The OJI reported that the trainee sat in at the high-level domestic position after receiving the briefing, and the OJI observed the trainee do a data board check; the OJI also did a scan of the data board. Prior to the occurrence, the trainee was responsible for five or six aircraft at any one time that were transiting through his sector. This traffic volume was assessed as light to moderate. Review of the sector's audio tape recording for the 30 minutes prior to the occurrence indicated nine aircraft on the frequency and a period of almost seven minutes with no radio transmissions just prior to the occurrence.

At 1926, BAW92X contacted the Gander ACC trainee with a position report over St. Anthony. The trainee had already marked BAW92X's data strip when he accepted the handoff from west radar and, nine minutes later, he wrote the aircraft's progress report on the flight data strip. The aircraft reported maintaining FL330 and the trainee told the pilot to contact Gander Radio in 100 miles. The trainee did not detect the conflict on the two strips under the St. Anthony fix designator, the red one for DAL49 and the black one for BAW92X, both marked at the same altitude.

At 1942, DAL49 contacted the Gander ACC trainee and reported at FL330, with an estimate for St. Anthony of 2019. The trainee issued the aircraft a domestic clearance and asked the pilot of DAL49 what altitude they were requesting. At that point the controllers realized that both DAL49 and BAW92X were at FL330, on the same track and possibly in conflict. After confirming that DAL49 was at FL330, the trainee cleared the aircraft up to FL350. The clearance to DAL49 did not include an instruction to expedite the climb or any traffic advisory about the position of BAW92X.

1.12.4 Oceanic Controller

The fourth opportunity to detect the conflict occurred when an oceanic controller took over the ocean sector from the first oceanic controller and his trainee at about 1905. When the relieving controller did his data board check, he did not notice that the flight data strips for DAL49 and BAW92X indicated that the aircraft were at the same altitude, travelling in opposite directions, on the same track.

About 1915, a second strip for BAW92X was produced with a speed change and no change to the routing. The oceanic controller received this new strip and compared it with the BAW92X strip already on the board. Once again, he did not detect the conflict with DAL49. The oceanic controller also did not detect the traffic conflict during his routine scan of the data board.

1.13 Controller Situational Awareness

Studies have shown that controllers form a mental picture of air traffic that assists with the conceptualization and prediction of aircraft movement. Information used to develop this picture comes from radar displays, aircraft position reports, and the data from flight progress strips. Maintenance of the picture is essential for controller situational awareness and effective air traffic control.

David Hopkin, in his book *Situational Awareness in Complex Systems* (Embry-Riddle Aeronautical University Press, 1994), makes the following observations about situational awareness in air traffic control:

> Situational awareness will be subject to the formation of habits, may be resistant to new evidence that appears to contradict what is already known, may be biased in the choice of what is relevant to it, and may be influenced, and perhaps overly influenced by memories which once recalled, may be treated as more relevant than they are.
>
> All the major proposed forms of computer assistance for air traffic controllers in performing their tasks, and all the intended forms of automation in air traffic control that are envisaged to have some consequences for the controller, must affect situational awareness. The reason is that all aids require new learning of some kind and situational awareness is a function of learning. The expressed anxieties about some of the consequences for situational awareness of increased air traffic control automation, such as an increased propensity for the controller to lose the picture or reduced controller understanding of the picture, seem to have some justification.

1.14 Controller Vigilance

In 1990, the Canadian Aviation Safety Board (CASB), as a result of a special investigation into air traffic control services, stated that inattention or lack of vigilance appears to be contributory in approximately 50 per cent of all air traffic services (ATS) occurrences, and that these types of errors often happen during periods of light, non-complex traffic. Complacency and boredom were considered to contribute to the frequency of attention-related occurrences.

2.0 Analysis

2.1 General

Sixty minutes had elapsed between the time the oceanic planner determined that FL330 was an appropriate altitude for BAW92X and the time of the occurrence. There were four opportunities for individual controllers to detect the conflict and correct it. Normally, aircraft separation, conflict detection, and conflict correction take place routinely, regardless of the traffic volume.

2.2 Traffic Volume

During the late afternoon, the traffic activity that normally follows the daily westbound flow is at its lowest. Changeover in the main-flow direction will take place over the next few hours and the controller evening shift changes are also taking place. Controllers arrive at their positions anticipating few traffic problems, knowing that the main traffic volume will occur later in the evening. Relieving controllers anticipate that the controllers being relieved will have already resolved any potential traffic conflicts or will point out unresolved traffic conflicts for their immediate attention.

Considering the conditions that normally exist, the first few hours of the evening shift are the least demanding of the shift. This established routine can engender a complacent attitude, causing a lack of vigilance and leading to a loss of controller situational awareness.

2.3 Traffic Conflict Detection

2.3.1 Oceanic Planner

If the oceanic planner had completed an adequate check of the ocean board, he might have detected the presence of DAL49 already over the ocean at FL330. In that case, he would not have planned BAW92X at the same altitude. Rather than checking the ocean data board himself, a more appropriate action for the oceanic planner might have been to interrupt the ocean controller and his trainee, or wait for an opportune moment, and discuss the altitude for BAW92X with him. The ocean controller, being more familiar with the traffic in his sector, might have been able to detect the conflict more easily than the planner.

2.3.2 High-Level Domestic Controller

When the high-level domestic controller received the flight data strip for BAW92X and placed it with the strip for DAL49 on the data board, he did not notice that both aircraft were at the same altitude. He did not detect the traffic conflict during the period that both strips were on his sector's data board. Given that the two differently coloured strips were the only two under the St. Anthony fix designator, it is likely that the high-level domestic controller's routine data board scan was ineffective.

2.3.3 High-Level Domestic OJI and Trainee

Although the controllers reported that a briefing was completed when the OJI and his trainee relieved the first high-level controller, the briefing did not include any information about the conflict between DAL49 and BAW92X. The data board checks performed by both the OJI and the trainee were ineffective, as neither detected the conflict at that time.

The trainee controller's mental picture of the air traffic and his situational awareness were inadequate. This is highlighted by his action of twice marking flight progress information on BAW92X's black data strip and failing to detect the traffic conflict, even though DAL49's red strip was the only other strip under the St. Anthony fix designator.

The section of domestic airspace where the occurrence took place does not have radar coverage. Even if radar coverage were available in this area, though, it is unlikely that the controllers would have detected the conflict, because the radar was centred to display the traffic on the tracks in the southern part of the airspace.

When the controllers detected the traffic conflict, they cleared DAL49 to climb without instructing the pilot to expedite, and they did not give a traffic advisory about BAW92X's position. It is possible that the actual air traffic picture deviated so greatly from the mental picture they had already developed that they did not give the most appropriate instructions to DAL49.

2.3.4 Oceanic Controller

If the controller who relieved the oceanic sector prior to the occurrence had done an adequate data board check, he would have detected the traffic conflict. When the oceanic controller received the second data strip for BAW92X with the speed change, he saw that it was not a routing change, assumed that the route was already free of traffic conflict, and did not check it against the other strips on the ocean data board. The oceanic controller did not detect the conflict during his routine scan of the ocean data board either.

2.4 Controller Situational Awareness

It is likely that the failure of the involved controllers to maintain their situational awareness was due to the development of a complacent attitude during a period of low traffic activity. Contributing to this complacent attitude was a reliance on automated systems, such as GAATS, and other controllers to detect potential traffic conflicts. This complacent attitude led to a lack of vigilance and less compliance with established procedures and checklists. When a traffic conflict does develop during a period of low traffic activity, as occurred on this occasion, it is less likely to be detected than it would be during a period of peak traffic activity.

Adherence to established procedures and the use of written checklists by the controllers would likely have resulted in earlier detection and resolution of the conflict, and would have reduced the risk of collision.

2.5 Traffic Alert and Collision Avoidance System

The crew of DAL49 decided to expedite the climb to FL350 after the first officer observed conflicting opposite-direction traffic at 30 miles on the TCAS. This decision was based solely on the TCAS information and resulted in the two aircraft achieving 1,800 feet vertical separation when they passed. Without an ATC instruction to expedite the climb and without the information provided by TCAS, the crew of DAL49 probably would have performed a slower en route climb, resulting in less vertical separation with BAW92X when they passed.

3.0 Conclusions

3.1 Findings

1. All the controllers involved in this occurrence were qualified and current at their positions.
2. All equipment available to the controllers was serviceable and being used.
3. Staffing in the Gander Area Control Centre met unit standards.
4. The traffic volume was assessed as light to moderate with normal complexity.
5. The oceanic planner did not detect a traffic conflict with DAL49 when he planned the altitude for BAW92X.
6. The first high-level domestic controller occupying the sector did not detect the traffic conflict between the two aircraft.
7. The OJI and high-level domestic radar trainee who relieved the sector did not detect the traffic conflict between the two aircraft.
8. The oceanic controller who occupied the ocean sector during the time prior to the occurrence did not detect the traffic conflict.
9. When the risk of collision was detected, DAL49 was not instructed to expedite the climb to FL350, and no traffic information was passed.
10. The crew of DAL49 decided to expedite their climb based on TCAS information about opposite direction traffic.
11. DAL49 passed about 1,800 feet above and one mile south of BAW92X.
12. Established procedures and written checklists for flight data board scans and sector briefings were not effectively followed.

3.2 Causes

The controllers involved in this occurrence did not detect the traffic conflict between DAL49 and BAW92X prior to the risk of collision. Contributing to this occurrence were the controllers' loss of situational awareness created by complacency and a lack of vigilance during a period of low traffic activity.

4.0 Safety Action

4.1 Action Taken

4.1.1 Transport Canada

Previous TSB investigations have shown that controller inattention, lack of vigilance, or loss of situational awareness are major factors in loss of separation occurrences. Therefore, subsequent to a risk of collision between two A320 Airbus aircraft in December 1993 (A93C0208), the Board recommended that:

> The Department of Transport sponsor research into methods for maintaining reliable controller vigilance in an increasingly automated ATC work environment.
>
> (A94-28, issued December 1994)

In response, Transport Canada (TC) indicated that research would be conducted on the most effective communication, focusing, and distraction-control techniques for air traffic controllers, and relevant training programs would be implemented. Additionally, TC has started research into other areas that affect controller vigilance and into programs designed to optimize controller health and performance.

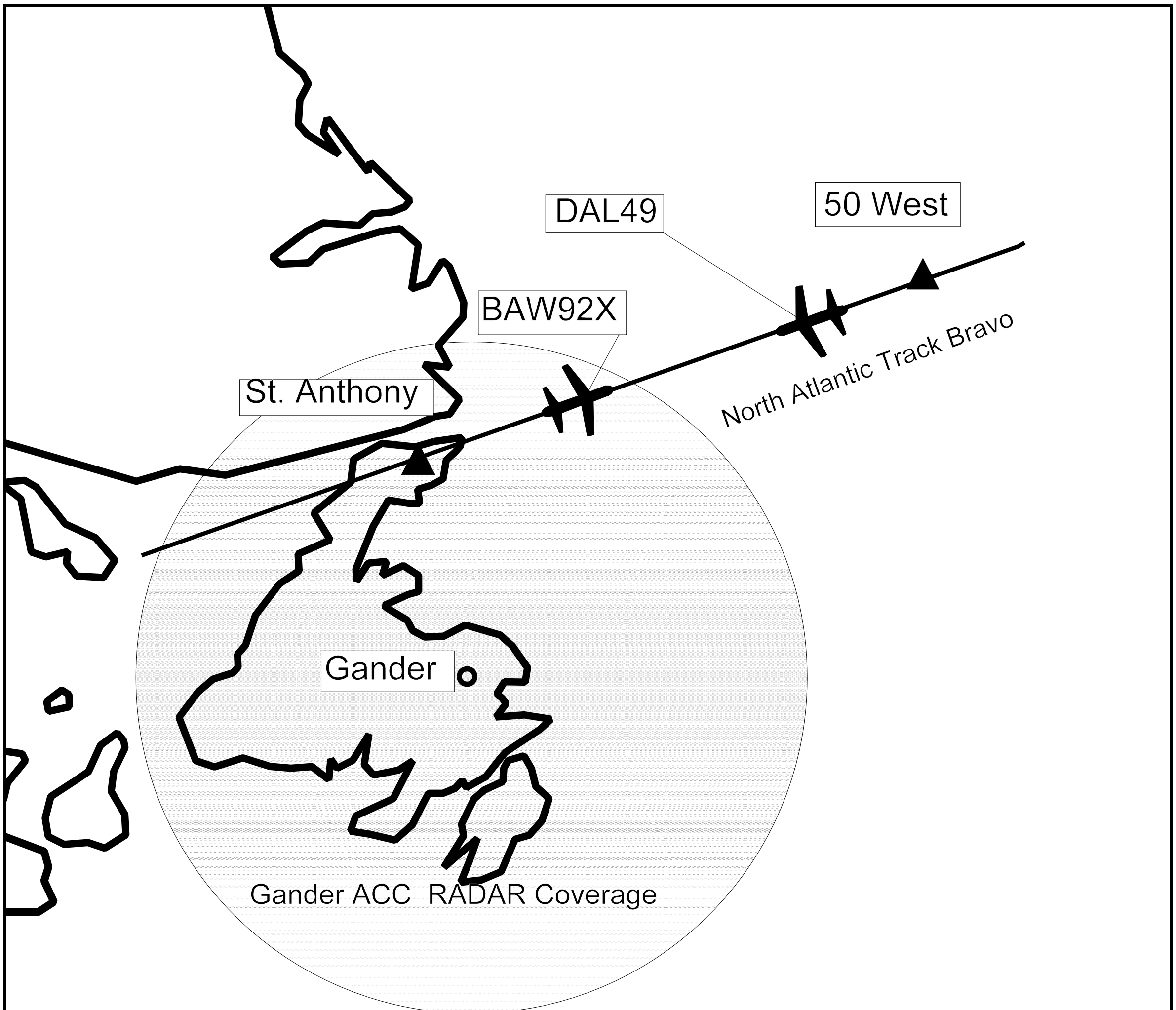
To address the issue of controller situational awareness in the short term, the Board recommended that:

> The Department of Transport provide training for Canadian controllers similar to crew resource management (CRM) training for pilots.
>
> (A94-29, issued December 1994)

In response, TC indicated its intention to develop a decision making course for controllers (similar to the pilot decision making (PDM) courses) which would include a discussion of the various factors that affect situational awareness.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Maurice Harquail, authorized the release of this report on 03 January 1996.

Appendix A - Occurrence Location Diagram



1926 BAW92X reported by St. Anthony at FL 330.
1936 DAL49 reported by 50 West at FL 330.
1943 DAL49 was cleared to FL 350.
1944 The aircraft passed with 1,800 feet vertical separation

Appendix B - Glossary

ACC	Area Control Centre
ATC	air traffic control
ATS	Air Traffic Services
BAW92X	British Airways flight number 92 X-ray
CASB	Canadian Aviation Safety Board
DAL49	Delta Airlines flight number 49
ETA	estimated time of arrival
FL	flight level
GAATS	Gander Automated Air Traffic System
IFR	instrument flight rules
MANOPS	Manual of ATS Operations
N	north
NAT	North Atlantic Track
NFLD	Newfoundland
OJI	on-the-job instructor
TC	Transport Canada
TCAS	Traffic Alert and Collision Avoidance System
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
W	west
yr	year (s)
50 West	53˚00' North latitude 50˚00'West longitude
°	degree(s)
'	minute(s)

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