

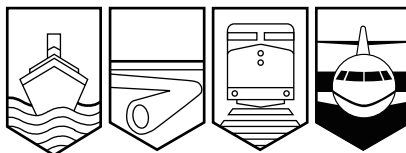
Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A02W0115



LOSS OF SEPARATION

NAV CANADA
EDMONTON AREA CONTROL CENTRE
EDMONTON, ALBERTA 60 NM S
27 JUNE 2002

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

Loss of Separation

NAV CANADA
Edmonton Area Control Centre
Edmonton, Alberta 60 nm S
27 June 2002

Report Number A02W0115

Summary

C-GKGM, a BA3112 operating as Corpac Canada Ltd. (Corporate Express) CPB888, was en route under instrument flight rules from Fort McMurray, Alberta, to Calgary International Airport, Alberta. C-FDMR, a SA227DC operating as Alta Flights (Charters Inc.) CNS213, was en route, also under instrument flight rules from Calgary International Airport to Edmonton City Centre Airport, Alberta. Because of extensive thunderstorm activity between Edmonton and Calgary and the restricted airspace associated with the G-8 Conference at Kananaskis, Alberta, both aircraft were diverted east of their flight planned routes. At 1610 mountain daylight time, approximately 60 nautical miles southeast of Edmonton International Airport, the aircraft met on a nearly reciprocal heading at an altitude of 16 000 feet above sea level. They had vertical separation of 200 feet and lateral separation of 1.3 nautical miles in an area where 1000 feet or 5 nautical miles is required. The aircraft passed in cloud and neither crew saw the other aircraft.

Ce rapport est également disponible en français.

Other Factual Information

Both aircraft were being controlled by the Edmonton Area Control Centre (ACC). The loss of separation took place in the Red Deer sector of the Calgary en route specialty.

CPB888 was flight planned at an altitude of 16 000 feet above sea (asl) and given a heading of 175° magnetic to intercept the 354° radial of the Calgary VOR. This heading resulted in a track of about 164° because of westerly winds. Control was handed off to the Edmonton departure sector, and then to the Red Deer en route sector. The aircraft remained at 16 000 feet.

CNS213 was flight planned from Calgary to Edmonton via V112 to the Edmonton VOR at 16 000 feet and proceeded at an initial altitude of 14 000 feet asl. Five minutes before the occurrence, the Red Deer sector radar controller cleared CNS213 to maintain 16 000 feet. When the two aircraft were about 4.2 nautical miles apart, the Edmonton terminal arrival controller noticed the conflict and drew it to the attention of the Red Deer data controller by land line. The data controller then verbally relayed this information to the Red Deer radar controller who instructed CNS213 to descend immediately to 15 000 feet.

During their scanning of flight progress strips and the radar display, the Red Deer en route sector controllers did not detect the conflict between the aircraft. Neither aircraft was fitted with a traffic alert and collision-avoidance system (TCAS), nor were they required to be by Canadian regulations. There was no ground-based conflict alert system in operation in Edmonton ACC at the time of the occurrence.

Airmet C1, a short term weather advisory issued at 1459 mountain daylight time¹, warned of a line of scattered cumulonimbus clouds developing in a line from northwest of Red Deer to southwest of Calgary, moving northeastward at about 10 knots. The cells were expected to strengthen, especially northeast of Calgary with tops expected to rise to between 38 000 and 45 000 feet.

For the three-day duration of the G-8 Conference at Kananaskis, Class F restricted airspace (CYR255) was established to prevent unauthorized aircraft from entering the area. CYR255 was an irregularly shaped area with an approximate 80 nautical mile radius around the conference site. (See Appendix A - Occurrence Diagram). Aircraft travelling west from Calgary had to be routed around the northeast corner of CYR255 in the Red Deer en route sector before proceeding west. Civilian flights were only to be allowed into the restricted area in emergency situations, and unauthorized aircraft penetrating the restricted area were at risk of being intercepted by military fighters.

A supervisor at the Edmonton ACC was assigned the role of G-8 Airspace Coordinator to liaise between the military and the ACC in the planning and management of G-8 restricted airspace. The coordinator completed his shift and left the ACC 40 minutes before the occurrence. No replacement was scheduled. Aircraft flying between Edmonton and Calgary diverted east around the thunderstorm activity, and because of traffic volumes at Calgary, four inbound

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

aircraft were instructed to hold short of Calgary terminal airspace for up to 20 minutes. With 13 aircraft operating in the Red Deer sector at the time of the occurrence, the traffic level was considered to be from moderate to high, with high complexity.

To deal with the anticipated workload associated with G-8 activities, the normal contingent of eight controllers working the Calgary en route sectors was increased to 11. At the time of the occurrence, eight controllers were active, while three were on breaks. The Red Deer en route sector was staffed by two controllers. A radar controller directed traffic flow within the sector by monitoring the radar display and handling communications with aircraft, and a data controller assisted the radar controller by administering flight progress strips and handling land line communications.

During the 34 minutes preceding the incident, the Red Deer en route sector radar controller was involved in 311 communications by radio or land line in addition to unrecorded conversations between the two controllers. Flight crews reported that based on the number of radio transmissions, the Red Deer sector was very busy.

At the time of the occurrence, the supervisor responsible for the Calgary en route specialty was working a controller position which was physically located directly behind the Red Deer sector. Supervisor duties included maintaining awareness of traffic situations, managing personnel, including breaks and, in conjunction with the shift manager, facilitating decisions on flow control implementation. Supervisors were also required to periodically work in control positions in order to maintain their qualification as controllers.

Both the radar and data controllers were licensed and current in accordance with existing regulations. The radar controller had 29 years of experience, with 14 years in the Calgary en route specialty. On the day of the occurrence, he reported for work at 0815 with the incident occurring about eight hours after the beginning of his shift, and 55 minutes after his last break. The data controller had 11 years of experience, with four years in the Calgary en route specialty. On the day of the occurrence, he reported for work at 0700 with the incident occurring nine hours after the beginning of his shift and 46 minutes after his last break.

Cognitive fatigue arises typically as the result of long periods of work involving high levels of information load.² Generally there are effects on short term memory, the timing of tasks, and attention.³ Both Red Deer sector controllers, as well as the supervisor, considered themselves to be somewhat tired near the end of their shifts because of the cumulative workload and extra vigilance associated with G-8 airspace activity.

Flow control is a tool used to reduce air traffic in terminal areas when the demand exceeds or is forecast to exceed system capacity. Two forms of flow control were used on the day of the occurrence in order to meter the traffic in the Calgary terminal area:

² Hockey, G.R.J. *Changes in Operator Efficiency as a Function of Environmental Stress, Fatigue, and Circadian Rhythms*; Boff, K.R., Kaufman, L. and Thomas, J.P., eds. *Handbook of Perception and Human Performance*: Vol. 11, New York: Wiley, 1986.

³ Stein, Earl S. and Smolensky, Mark W. *Human Factors in Air Traffic Control*; San Diego: Academic Press, 1998.

- Air stop, which controls the flow of traffic into the Calgary terminal airspace by placing aircraft in holds outside the terminal area for intervals of up to 20 minutes.
- Ground delays, which space aircraft departures from other airports in order to meter traffic into the terminal area.

In the Edmonton ACC, authority to implement flow control was a responsibility of the duty shift manager. En route sector controllers or supervisors were normally consulted regarding initiating or cancelling flow control procedures. The Calgary terminal control coordinator had been delegated the authority to implement tactical flow control, when needed, for Calgary Airport.

At 1430, the Calgary Airport was closed to protect the departure of G-8 VIP aircraft. At 1530, after most VIP aircraft had departed, the Calgary terminal control coordinator lifted the closure and initiated flow control to meter arrivals and departures at Calgary. This flow control took the form of ground delays with five-minute intervals between departures of similar aircraft from Edmonton to Calgary, as well as an air stop on traffic destined for Calgary. Four southbound aircraft, including CPB888, were either being held or were being set up for 20-minute holds outside the Calgary terminal shortly before the occurrence. Since the TORON intersection was not available as a holding fix because of weather, the Red Deer radar controller had to develop revised holding fixes. In addition, a "16/17" split was in effect at the request of the Calgary terminal, whereby inbound traffic was generally kept at 17 000 feet and above and outbound traffic was kept at 16 000 feet and below. The G-8 coordinator had departed the operations room and the Red Deer sector supervisor was working a control position. Although neither person was available to respond to the Red Deer controller's concern for the building traffic levels, an on-duty shift manager was assigned to traffic management oversight relating to G-8 activities.

Preferred IFR Routes listed in the *Designated Airspace Handbook* TP1820 are described in the *Air Traffic Control Manual of Operations (ATC MANOPS)* as a method of providing an efficient and orderly management of air traffic normally using the airway system by:

- guiding pilots in planning their route of flight;
- minimizing route changes during the operational phase of flight; and
- aiding in the efficient and orderly management of air traffic using the airway system.

Canadian Aviation Regulation (CAR) 602.34 requires that aircraft operate at a cruising altitude or a flight level appropriate to the track as set out in a table accompanying the regulation unless assigned another altitude by ATC. Aircraft flying on tracks between 180° and 359° must cruise at even altitudes (eg: 14 000, 16 000, 18 000, etc.) and aircraft on tracks between 000° and 179° must fly at odd altitudes (eg: 13 000, 15 000, 17 000, etc.) As published in the *En route Low Altitude* charts published by Natural Resources Canada (*LO1* and *LO2*), for southbound aircraft on V21, even altitudes were appropriate for direction of flight between Fort McMurray and the Edmonton VOR, with odd altitudes appropriate for the remainder of the route to TORON intersection.

ATC MANOPS, section 432, states that inappropriate cruising altitudes may be assigned if:

- no alternative separation minima can be applied;
- the airspace is structured for one-way traffic flow; or
- an aircraft requests it because of icing, turbulence, or fuel considerations.

None of these criteria applied during this occurrence. Although V21 was a preferred route southbound between Edmonton and Calgary, it was not designated to be structured for one way traffic.

ATC MANOPS, section 432.6, specifies that controllers must identify aircraft which are cleared for altitudes inappropriate for the direction of flight when:

- passing and receiving a control estimate;
- giving and receiving a radar hand-off; and
- coordinating with an adjacent sector/unit.

Controllers are also required to post warning indicators by circling the altitude in red on the appropriate flight progress strip.

During control of CPB888 through the Edmonton terminal and the Red Deer en route sectors, the foregoing actions were not performed while the aircraft was at the altitude inappropriate for direction of flight.

Controller performance monitoring and quality assurance were accomplished primarily through semi-annual "over the shoulder" checks and ongoing, daily supervision. The scheduled checks were conducted by a supervisor using a standardized checklist, and included strip marking practices. Occasionally, reviews of radar and audio tapes were made by NAV CANADA head office personnel as a function of periodic audits. In the Edmonton ACC, it was not a normal management practice to carry out random, unscheduled quality assurance checks of flight progress strips for issuance of appropriate altitudes and proper marking. After the occurrence, a survey of flight progress strips for aircraft transiting from Fort McMurray to Calgary through Edmonton terminal and Calgary en route airspace was carried out. At least six aircraft were cleared through those sectors at inappropriate altitudes over a 24-hour period without meeting the *ATC MANOPS* criteria for justification and strip marking. NAV CANADA did not have a national policy of random, unscheduled strip examination as part of a quality assurance program.

The planning section of the *Canada Flight Supplement (CFS)*, in addition to listing the preferred IFR routes, states "In Class A and Class B airspace between Edmonton and Calgary, altitudes and flight levels which are not appropriate for the direction of flight may be assigned by ATC at any time to an aircraft operating to a maximum of FL250 on the preferred route". Based in part on the *CFS* statement, pilots seldom questioned controllers on the issuance of altitudes inappropriate for the direction of flight.

The *LO1* and *LO2* charts contained an error in the depiction of V21. On *LO1*, even altitudes were shown to be appropriate for aircraft northbound on V21 between the Edmonton VOR and the *CALLY* intersection. On *LO2*, even altitudes are shown to be appropriate for the opposite direction on the same section of the airway.

Analysis

The occurrence took place during a combination of circumstances involving active weather, restricted airspace, reduced supervision, and a high concentration of complex air traffic. Because of high workload in their sector, the Red Deer en route sector radar and data controllers were not able to effectively cross-check flight progress strips and the radar displayed traffic. As a result, both controllers' situational awareness became degraded and the potential conflict between CNS213 and CPB888, which was operating at an altitude inappropriate for the direction of flight, went unnoticed.

When the security closure of Calgary terminal was lifted, there was a surge of traffic into and out of Calgary. Aircraft were released using ground delay and air stop flow control procedures at a rate that was primarily set in consideration of the traffic acceptance rate of the Calgary terminal facilities. The combined effects of weather, restricted airspace, and concentration of traffic volumes in the Red Deer en route sector resulted in concentrating the backlog in the Red Deer sector. Flow control, a tool primarily aimed at traffic management in terminal areas, had an adverse effect on the en route sector in this occurrence.

With extensive thunderstorm activity blocking the direct routes between Edmonton and Calgary, and with CYR255 restrictions precluding diversions to the west, the Red Deer en route sector controllers had to send much of their traffic into the eastern portion of the sector. The G-8 coordinator was unavailable and the Red Deer sector supervisor, working a controller position, was unable to respond to the controllers' concern for the building level of traffic. The controllers were therefore unable to obtain effective flow control measures to alleviate traffic concentration in their sector.

Because of the possibility of armed interception of unauthorized aircraft inadvertently entering CYR255, the radar controller focussed much of his attention to westbound airline flights from Calgary that were transiting the narrow airspace between thunderstorm activity and the restricted airspace. This added to the workload associated with the negotiation of weather avoidance deviations and the vectoring of several aircraft which were in the eastern portion of the Red Deer sector. The complexity of traffic in the sector was increased by the 16/17 split, which, in effect, reduced the altitudes available to the controllers and added to controller workload.

During the time leading to the occurrence, the Calgary en route specialty was not considered to be short-handed. ACC management had increased staffing in anticipation of a higher, more complex workload; however, three of the 11 specialty controllers were on a break. Exercising his option of bringing at least one controller off break would have freed up the supervisor to assume supervisory duties rather than occupy a controller position. He then may have been able to assist the Red Deer controllers in managing traffic in their sector.

The radar and data controllers, and the supervisor, indicated that they felt somewhat fatigued because of increased cumulative workload associated with G-8 activities and weather diversions. Although there were no clear indications that fatigue was a factor in the occurrence, the effects of cognitive fatigue—reduced short term memory, inappropriate timing of tasks, and reduced attention levels—have been shown to result in reduced performance in air traffic controllers. A lack of proper marking of the flight progress strips and ineffective scanning of the radar display were both shown to have been factors in this occurrence.

When CPB888 passed from the La Biche, Alberta, en route sector to the Edmonton north terminal sector, its altitude of 16 000 feet was appropriate for the direction of flight. After the aircraft turned onto a track of 164°, 16 000 feet was then inappropriate. NAV CANADA had no policy to routinely clear southbound aircraft through Edmonton terminal into the Red Deer sector at altitudes inappropriate for direction of flight. There was no provision in the preferred route system to abrogate the responsibility of controllers to follow ATC *MANOPS* and *CARs* requirements. Since much of the traffic in the sector spent a significant amount of time climbing or descending in association with the terminal areas, it had become normal among controllers to vector aircraft toward the TORON intersection at inappropriate altitudes, often without following *MANOPS* guidelines regarding implementation, hand offs, and strip marking.

The crew of CPB888 filed 16 000 feet for the entire route, even though a change in track at the Edmonton VOR would warrant an altitude change. They anticipated remaining at 16 000 feet consistent with previous experience, and the turn to a direction which required a different altitude did not pose any concern. There are indications that pilots in local companies, including those involved in the occurrence, were accustomed to receiving altitudes inappropriate for the direction of flight through the Edmonton terminal and Red Deer en route sectors, and would seldom query controllers on the validity of these altitudes. This was likely due, in part, to the CFS planning section statement that pilots may be cleared at inappropriate altitudes for direction of flight on preferred routes between Edmonton and Calgary.

The flight progress strips for both aircraft were not marked by the Red Deer en route sector data controller in accordance with ATC *MANOPS* instructions. The marking procedure was designed to alert controllers to potential conflicts arising from aircraft operating at altitudes inappropriate for the direction of flight. By not checking flight progress strips on a regular and random basis for conformance to standards regarding the issuance of altitudes and strip marking, NAV CANADA management personnel in the Edmonton ACC were unaware that Edmonton terminal and Red Deer sector controllers were not consistently adhering to mandatory procedures for altitude assignment.

At the time of the occurrence, an air traffic conflict alert system was not fully installed and serviceable in the Red Deer en route sector of the Edmonton ACC. These systems are designed to alert controllers to the potential conflict between two aircraft.

An inconsistency existed in the depiction of altitudes appropriate for direction of flight on V21 on the *LO1* and *LO2* charts, which were valid at the time of the occurrence. Although it was not considered to be a factor in this occurrence, this error could potentially result in confusion in altitude flight planning and air traffic control.

Findings as to Causes and Contributing Factors

1. CPB888 was allowed to operate at an altitude inappropriate for the direction of flight through the Edmonton terminal and Red Deer en route sectors of the Edmonton ACC. This reduced the safety margin required by the *CAR* for opposite direction traffic operating at segregated altitudes.
2. Flight progress strips were not marked to alert controllers that CPB888 was operating at an inappropriate altitude for the direction of flight. This reduced the likelihood that controllers would detect a potential conflict with opposite direction traffic operating at appropriate altitudes.

3. The radar controller did not adequately scan the radar display for other traffic prior to clearing CNS213 to the altitude occupied by CPB888, and the conflict between the two aircraft went undetected.
4. When the new altitude of 16 000 feet for CNS213 was entered on the flight progress strip, there was insufficient review of other flight progress strips on the data board in order to determine if there was a conflict with other aircraft. CPB888 and CNS213 were then allowed to operate at the same altitude in opposite directions.
5. A complex traffic situation brought about by the release of aircraft following the Calgary terminal air stop, G-8 airspace restrictions, a 16/17 altitude split, and thunderstorm activity imposed a high workload on air traffic controllers in the Red Deer en route sector. Flow control, as a tool primarily aimed at traffic management in terminal areas, had an adverse effect on the en route sector in this occurrence.
6. With the supervisor working a control position rather than bringing a controller back from a break, personnel were not effectively managed in the Calgary en route specialty during a busy and complex traffic situation.

Findings as to Risk

1. The *Canada Flight Supplement* planning section states that altitudes inappropriate for direction of flight may be assigned by ATC at any time on the preferred routes between Edmonton and Calgary. This may also reduce the likelihood of pilots questioning the validity of the use of such altitudes.
2. There was an inconsistency in the depiction of appropriate altitudes for direction of flight for V21 on charts *LO1* and *LO2*. As a result, there is a risk of confusion on the part of pilots and controllers and the possibility of aircraft being cleared for the same altitude in opposite directions on the airway.

Safety Action

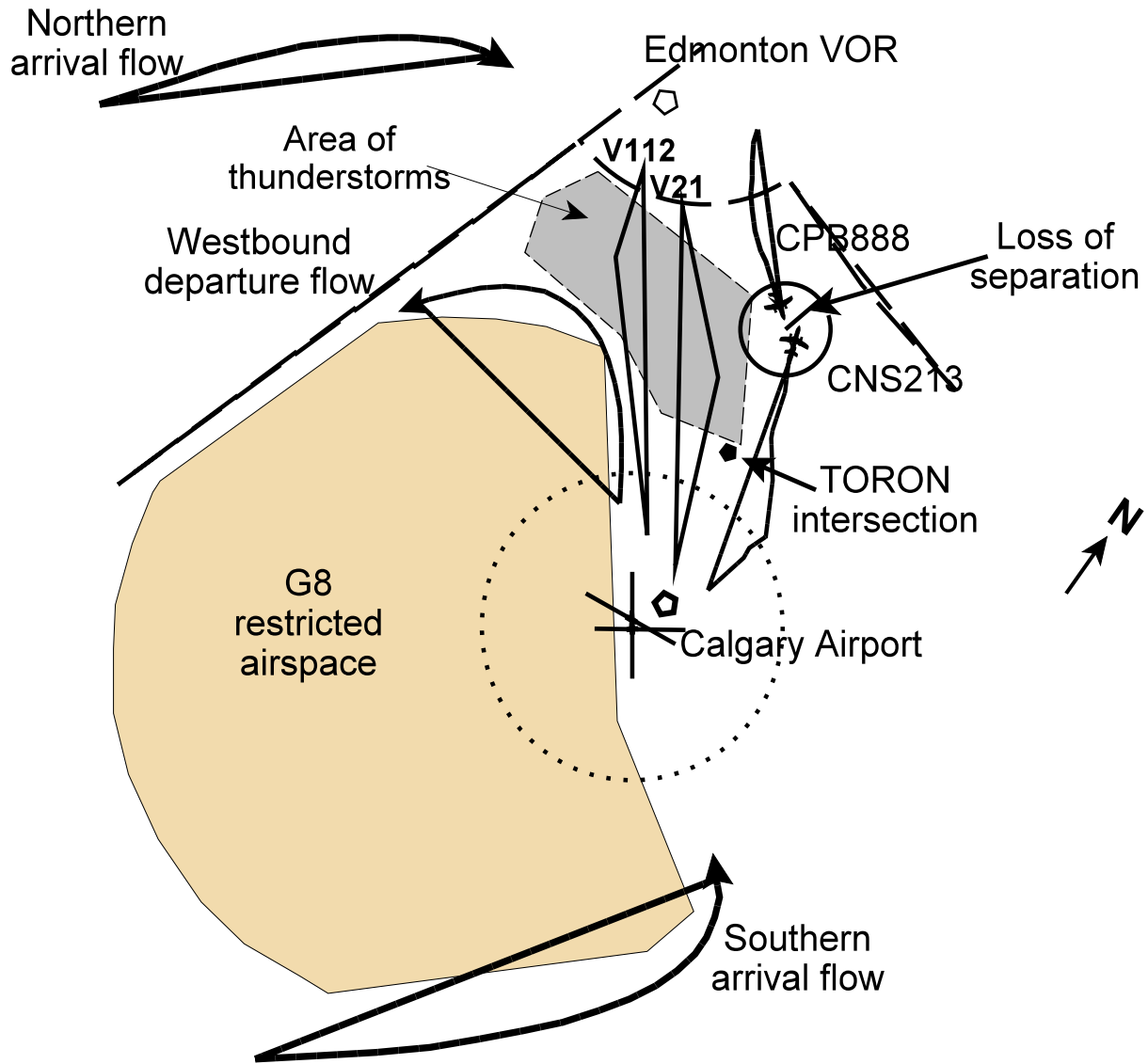
In response to indications that controllers in the Edmonton ACC were not consistently following procedures in accordance with strip markings for aircraft operating at altitudes inappropriate for the direction of flight, the NAV CANADA Edmonton ACC issued an operations bulletin drawing to the attention of controllers the necessity of following *ATC MANOPS* directives.

Since the occurrence, an air traffic conflict alert system has been installed, tested, and put into service in the en route sectors of the Edmonton ACC. The system alerts controllers of potential conflicts for aircraft at altitudes at and above 14 000 feet.

NAV CANADA issued a Notice to Airmen (*NOTAM*) which communicated the issue of inaccurate depiction of V21 on chart *LO2*. A permanent revision has been made on the amendment effective 15 May 2003.

This report concludes the TSB's investigation into this occurrence. Consequently, the Board authorized the release of this report on 28 July 2003.

Appendix A - Occurrence Diagram



Note: Other air traffic not shown

Not to scale