AVIATION OCCURRENCE REPORT

RISK OF COLLISION

BETWEEN
CANADA 3000 AIRBUS SA320-212 C-GVXF
AND
SEMITOOL INC. ROCKWELL INTERNATIONAL 690C N48BA
CALGARY, ALBERTA
21 APRIL 1998

REPORT NUMBER A98W0079

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Summary

At about 1935 mountain daylight time (MDT), a Canada 3000 Airbus 320, designated CMM368, took off from runway 28 at the Calgary International Airport for Toronto Lester B. Pearson International Airport, to climb to 7,000 feet for vectors. On contact with Calgary Departure, CMM368 was cleared to climb runway heading to maintain flight level (FL) 250. At about this time, a Turbo-Commander 690, designated N48BA, departed Calgary runway 34 for Kalispell, Montana. On contact with Calgary Departure, N48BA was cleared to climb to FL 210, and was given two right turns, the last to a heading of 150°M. During initial climb, CMM368 was given two left turns then cleared direct to the Empress Intersection; the heading was 090°M. When CMM368 was at about 12,000 feet and 300 KIAS, a traffic collision avoidance system (TCAS) Traffic Advisory (TA) was received, with the target displayed at the eleven o'clock position at 3 to 4 miles, 700 feet below and climbing. Immediately thereafter, a Resolution Advisory (RA) was received with the command "DESCEND CROSSING DESCEND". The captain initiated a descent. At this time, the pilot of N48BA sighted CMM368, turned right, and increased his rate of climb. At about the same time, a second RA commanded the pilot of CMM368 to "INCREASE
DESCENT". CMM368 came within 500 feet horizontally and 500 feet vertically of N48BA in an area where either 3 nm horizontal or 1,000 feet vertical separation is required. Prior to the risk of collision, the last air traffic control (ATC) communication with either aircraft was at 1939:50 MDT.

Ce rapport est également disponible en français.

Other Factual Information

Assignment of take-off runways are predicated, in part, by noise abatement procedures as published in the *Canada Air Pilot* and, in part, by *NAV CANADA ATC Sector Procedures Manual*. *Canada Air Pilot* published *Noise Abatement Procedures* for Calgary state:

> Subject to operational requirements ICAO Annex 16 Chapter 2 aircraft with northern or eastern designations will be assigned runway 34 for take-off.

CMM368 requested and was cleared for a runway 28 departure. Noise abatement procedures require an A320 type aircraft using runway 28 to "climb on the LOC 281° to 6 500 feet ASL before proceeding on course." ATC issued climb and turn restrictions based on noise abatement requirements and subsequently turned the aircraft left, based on arriving and departing traffic, after it had climbed sufficiently not to be a noise problem.

ATC Operations Letter #97/12 specifies procedures to be used for the control and coordination of flights operating within airspace assigned to the Calgary Terminal Specialty. At the time of the occurrence, a two-runway system (co-active runways) was being used in Calgary. Based on these standard operating procedures, north and eastbound traffic were being released from runway 34, and south and westbound traffic were being released from runway 28. CMM368 was eastbound and requested and received clearance to depart from runway 28. N48BA was taxiing from the south end of the airport and, to reduce taxi time, was cleared to depart from runway 34. Departing instrument flight rules (IFR) traffic is maintained at altitudes of 9,000 feet and below until clear of arriving IFR aircraft which is restricted to 10,000 feet until over specific geographical locations, unless otherwise coordinated between the arrival and departure controllers.

The Departure Controller was coordinating traffic with the Arrival Controller and, based upon arriving traffic, cleared both aircraft to their flight planned altitudes as soon as he considered it to be practical. On initial contact with the Departure Control, CMM368 was cleared to FL 250. Two minutes later, N48BA first contacted the Departure Controller and was cleared to FL 210. At the time, CMM368 was in a climb, west of Calgary at 8,500 feet and 190 knots.

The *NAV CANADA ATC Manual of Operations (MANOPS)* provides direction for controllers with respect to vertical separation standards. Part 4, paragraph 482.3, states in part:

> You may assign an altitude to an aircraft, only after an aircraft previously at the altitude, or an aircraft climbing or descending through the altitude, has reported or is observed (JETS):
>
> A. leaving or passing the altitude; or Part 5, paragraph 503.8 states in part:
>
> You may use validated altitude readouts to determine aircraft altitudes as follows:
>
> D. Consider an aircraft to have passed an altitude, when its altitude readout value has changed by 300 feet or more in the appropriate direction.

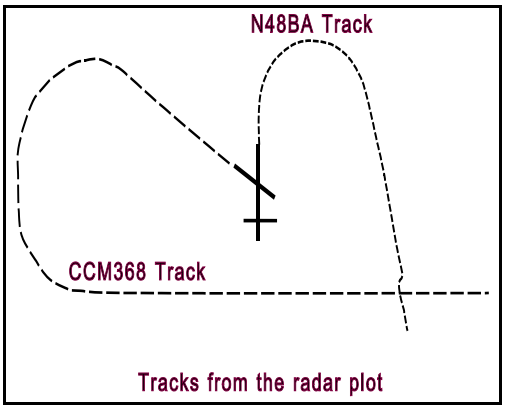
At the time, N48BA was cleared to FL 210, CMM368 was passing through 8,500 feet and had been cleared to FL 250. The aircraft were being vectored towards the same airspace, thus requiring positive separation.

On initial climb off runway 28, the speed and rate of climb of CMM368 was about 190 KIAS and 3,200 feet per minute (fpm). Once on course to Empress Intersection, the captain selected a managed speed to 320 KIAS which resulted in a rate of climb of about 800 fpm while the aircraft was accelerating. N48BA was climbing at about 180 KIAS and 1,800 fpm.

At 1939:50[1], 1 minute 20 seconds before CMM368 communicated a TCAS descent, CMM368 was about 10 nm south-west of the airport in a left turn climbing through 10,100 feet at 230 KIAS and N48BA was about 4 miles north-east of the airport in a right turn climbing through 7,200 feet. The air traffic controller assessed that the vertical and lateral spacing would remain adequate for the intended tracks. He then turned his attention to other aircraft under his control. He recalls that it was not until CMM368 called a TCAS descent that he looked at the two aircraft targets on his radar screen.

During the period from just before CMM368 took off and the time of the loss of separation, traffic conditions at Calgary International Airport were reported as being moderate and of moderate complexity. Staffing in the Calgary Terminal Specialty met unit standards. The shift supervisor was staffing one of the terminal positions in a relief capacity, as is customary for the scheduling of staff breaks. The weather at the time was visual meteorological conditions (VMC) with high thin scattered cloud.

Flight CMM368 operated from Calgary International Airport at the same time each weekday. With exposure and experience, air traffic controllers gain knowledge of aircraft climb profiles and are able to predict, with a high level of confidence, climb rates and ground speeds for various types of aircraft. However, where more that one flight profile is available to the pilot, such as is the case for the A320 aircraft, and when the pilot has not received any restrictions based on altitude, airspeed, or geographic location, the air traffic controller may not be aware of the pilot's intentions.



The original performance specifications for the ATC radar data processing system (RDPS) software included provisions for aircraft conflict alert detection. During testing in the late 1980s and early 1990s, the RDPS conflict alert function was found to have several faults and was not considered acceptable for operational use. Software testing of a conflict alert function is currently underway with on-site testing planned for late in 1998. Operational acceptance is expected to be a lengthy process.

Analysis

When a two-runway system is in use at Calgary International Airport, normal departure procedures result in north and eastbound traffic departing from one runway while west and southbound traffic depart from the other runway. This procedure eliminates the need to have flight paths cross after departure, and provides positive lateral separation. Normal procedure for the two aircraft involved would have been for CMM368 to take off

[1] All times are MDT (Coordinated Universal Time minus six hours) unless otherwise noted.

from runway 34 and N48BA to take off from runway 28. However, due to the location on the airport of executive aircraft, they are normally released from runway 34 when that runway is active. The controller's willingness to shorten the taxi distances for both aircraft resulted in a change to the normal flow of departure traffic. Furthermore, had both aircraft departed runway 34, separation would have been assured because of the direction of flight after departure.

As the aircraft were being vectored to crossing tracks, adherence to appropriate ATC MANOPS would have assured separation. When N48BA contacted the Departure Controller, CMM368 was climbing and passing through 8,500 feet. Thus, the appropriate altitude clearance limit for N48BA would have been 8,000 feet.

Any deviation from defined procedures adds to the workload of a controller in the form of extra vigilance and communications. If extra safeguards are not put in place at the time of the deviation or additional time available to monitor the situation until positive separation is achieved is not available, then there is a higher risk of something going wrong. The pressure to move traffic quickly, without undue delay, was the overriding factor in the decision to allow the two aircraft to depart from non-standard runways. The tower and departure controllers have available to them an electronic display which indicates, among other information, the departing runway. The Departure Controller can deny a non-standard departure if traffic warrants. In this case, the controller chose to allow the departures to proceed. Based on previous experience and judgement, the Departure Controller vectored both aircraft to a position from which they could commence their own navigation to the cleared outbound route. At this point, the Departure Controller determined that adequate spacing existed to allow each aircraft an unrestricted climb. Previous experience with these types of aircraft reinforced this perception. In the mind of the controller, the task to separate these two aircraft was now completed and only required sufficient radar monitoring of the flights to ensure a timely hand-off to the next sector.

The change in rate of climb of the A320 aircraft was not detected because the Departure Controller did not sufficiently monitor the progress of this flight. His experience did not include the possibility of the aircraft performance changing and affecting the spacing established with the other aircraft. The distraction caused by other control responsibilities and an inadequate periodic scan of the radar display resulted in the failure of the controller to detect this change. There have been a number of recent TSB reports (A97C0144, A97H0007, A98H0002) where controllers have not detected impending conflicts because of inadequate scanning techniques and the absence of additional progress reports requested by the controller. A deviation from normally expected procedures therefore requires additional safeguards to ensure that the safety margins intended by the standard procedures are maintained. This usually requires extra vigilance by the controller or additional checks and balances to be incorporated to ensure that the required separation standards are satisfied.

Once the air traffic controller turned CMM368 east towards the Empress Intersection and N48BA south, he checked their respective altitudes and ground speeds. Based on the experience he had gained in controlling other A320 aircraft departures at Calgary, he expected the A320 to continue its climb rate of about 2,500 fpm thus achieving greater than the minimum separation requirements for the two aircraft during their crossing. He did not anticipate that the pilot of the A320 would change his flight profile and thus reduce the aircraft climb rate to about 800 fpm while increasing the speed by about 100 knots. He assumed that certain profiles would be flown and did not recheck the progress of either aircraft until collision avoidance was being taken by the aircraft.

Prior to reaching 10,000 feet, the pilot was cleared to a higher altitude without airspeed restrictions. On reaching 10,000 feet, the pilot selected a higher speed which results in the aircraft rate of climb being reduced

until that speed is attained. The profile flown by the A320 aircraft was consistent with normal operating procedures for the A320 aircraft.

There are several tools available to controllers to assist them in monitoring traffic under their control. One non-radar tool is specifying reports from the crew of the aircraft such as altitude or position reports in addition to any already prescribed. This alerts the controller should a situation change from what was expected, and allows the controller to confirm that the originally envisaged plan is unfolding as desired. The RDPS provides two functions to assist the controller in accurately determining the position of the aircraft. The first is called a predicted track line (PTL), which projects a line from selected aircraft along its current heading, and which can be set for any variable time period from 1 minute to 20 minutes. The second tool is called a range bearing line (RBL) which will display a line joining two aircraft targets, an aircraft to a ground position or two ground positions, and show range and bearing data. This information is updated for each sweep of the radar. Neither of these two tools would have prevented the loss of separation or provided an audible or visual alarm to the controller. However, had either been used in this situation, it may have provided a reminder to the controller that the unusual flight path of the two aircraft, different from the normally used procedures, required an extra level of monitoring.

The PTL and RBL do not satisfy the requirements of a conflict alert tool. This type of system would provide some type of warning to the controller that a loss of separation is imminent and that action is required to resolve it. The RAMP radar system was to have this capability functioning when the system was commissioned. Technical problems, which persist to this day, have prevented the conflict alert system from being implemented. There are operational conflict alerting systems in use in other parts of the world. This type of tool would provide an additional safeguard, much as TCAS does, to avoid losses of separation or mid-air collisions.

Findings

1. Staffing in the Calgary Terminal Specialty met unit standards.

2. The controller's workload was assessed as moderate with moderate complexity.

3. The supervisor was staffing a position in relief during scheduled break rotation.
4. All necessary equipment was serviceable at the time of the occurrence.

5. Co-active runways were being used at Calgary International Airport.

6. North and eastbound traffic normally depart from runway 16/34 and south and westbound traffic normally depart from runway 10/28 during co-active runway operations.

7. Based on their direction of flight, both aircraft took off on the non-standard runways.

8. Procedures for assuring positive separation of aircraft, as specified in *NAV CANADA ATC MANOPS,* were not followed.

9. The air traffic controller did not monitor the progress of the two aircraft for a period of about two minutes prior to the TCAS alert.

10. A risk of collision occurred when CMM368 came within 500 feet horizontally and 500 feet vertically of N48BA in an area where either 3 nm horizontal or 1,000 feet vertical separation is required.

Causes and Contributing Factors

A risk of collision occurred when the departure air traffic controller did not follow ATC MANOPS separation criteria for two aircraft which were to occupy the same airspace, and then did not adequately monitor the progress of the two aircraft for a period of about two minutes. The reason for not monitoring the aircraft involved was based on controller expectations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 28 April 1999.