

AVIATION INVESTIGATION REPORT

A01W0144

LOSS OF SEPARATION

BETWEEN

AIR CANADA BOEING 737-200 C-GCPM

AND

AIR CANADA BOEING 737-200 C-GCPV

EMPRESS, ALBERTA, 5 NM W

15 JUNE 2001

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

Between

Air Canada Boeing 737-200 C-GCPM
and Air Canada Boeing 737-200 C-GCPV
Empress, Alberta, 5 nm W
15 June 2001

Report Number A01W0144

Summary

Two aircraft lost separation near the Empress VOR (very high frequency omnidirectional radio range). Eastbound Air Canada Flight 3696 (ACA3696), a Boeing 737-200, was en route from Calgary, Alberta, to Winnipeg, Manitoba, at flight level (FL) 330 and proceeding to the Empress VOR. Westbound Air Canada Flight 3627 (ACA3627), a Boeing 737-200, was en route from Winnipeg to Vancouver, British Columbia, at FL330 and deviating north of the planned track because of weather. Both aircraft were near the Empress VOR when ACA3627 was cleared direct to the Calgary VOR, when able. ACA3627 acknowledged the clearance but turned toward the Empress VOR, which was not on the track to Calgary. Approximately four minutes later, the Alsask sector controller advised ACA3627 to turn right for traffic. The crew of ACA3627 replied and advised that they were descending in accordance with a traffic alert and collision-avoidance system (TCAS) resolution advisory (RA). At the same time, the flight crew of ACA3696, having seen ACA3627 approaching off to the left and at the same flight level, commenced a slight turn to the right, then received a TCAS RA to climb. Instead of climbing, the crew of ACA3696 increased their bank angle to 45° and encountered buffeting. The crew commenced a descent in reaction to the buffeting, and air traffic control was advised that they were descending in response to a TCAS RA. The flight crew arrested the descent after 300 feet, levelled the wings, and climbed back to FL330. During the manoeuvre, one flight attendant and two passengers received minor injuries.

Ce rapport est également disponible en français.

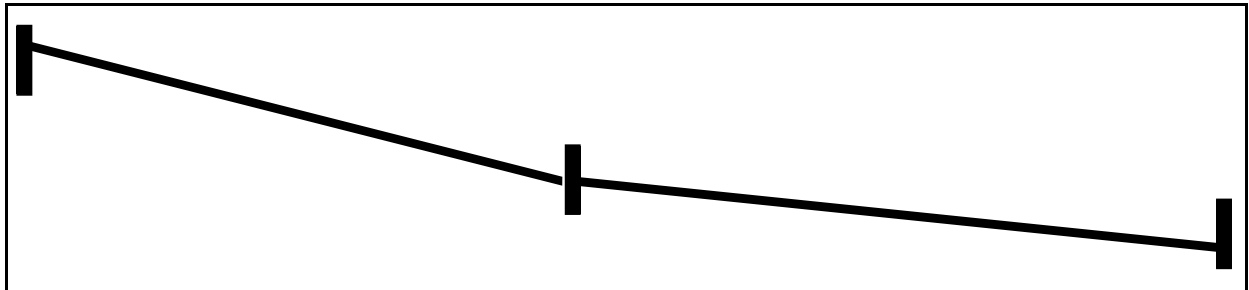
Other Factual Information

Westbound ACA3627 was between Winnipeg, Manitoba, and Regina, Saskatchewan, when the crew requested deviations north of their assigned track because of weather. To accommodate this request, air traffic control (ATC) asked if the crew could climb from flight level (FL) 310 to FL350. Because of the aircraft's weight, ACA3627 advised that they could not accept FL350; ATC offered FL330, and the crew accepted.

FL330 was inappropriate for the direction of flight. Inappropriate flight levels can be assigned under specified circumstances, as outlined in the Nav Canada *Air Traffic Control Manual of Operations* (ATC MANOPS), section 432. In this situation, the controller could not employ lateral separation because of weather and could not apply vertical separation because of the performance limitations of ACA3627. The altitude was approved by the affected sectors and units through which the aircraft would be passing, and appropriate markings were placed on the flight progress strips.

At the time of the occurrence, the first officer of ACA3627 was retrieving destination weather from Air Canada Calgary dispatch via the No. 2 VHF radio. The poor reception required that the squelch be turned off, which increased the background noise in the first officer's headset. Consequently, the first officer could not hear any communications from ATC on the No. 1 VHF radio. The captain was the only flight crew member to receive and execute the clearance to proceed to the Calgary VOR (very high frequency omnidirectional radio range). Air Canada Boeing 737 aircraft, like many older aircraft, are not equipped with an Arinc communications addressing and reporting system (ACARS). This system allows flight crew to receive text messages such as weather, arrival information, and weight and balance figures from company operations via datalink rather than voice. It also allows the flight crew to send messages.

The captain of ACA3627 acknowledged, but did not read back, the clearance (instruction) to proceed to the Calgary VOR when able. Canadian Aviation Regulation (CAR) 602.31 and section 1.7 of *Aeronautical*



Information Publication's (AIP) Rules of the Air (RAC) only require a pilot to acknowledge an ATC instruction. ATC MANOPS, however, requires the controller to obtain a readback of instructions issued by the controller to the pilot. All ATC clearances issued to aircraft in flight are to be read back. The controller did not request a readback of the instruction to proceed direct to Calgary.

Approximately four minutes after issuing the clearance to ACA3627, the controller noticed that ACA3627 had turned toward the Empress VOR. During this time, the controller completed 26 communications with five different aircraft and with two sector controllers. When the controller noticed the deviation, the distance between the two aircraft had reduced to five nautical miles. The controller queried ACA3627 as to which VOR they were going to and stated that they should turn right for traffic. During this communication, ACA3627 and ACA3696 received a traffic alert and collision-avoidance system (TCAS) resolution advisory (RA).

Earlier in the flight, the Winnipeg Area Control Centre (ACC) controller had cleared ACA3627 to proceed direct to Calgary. Analysis of the recorded radar information indicated that the aircraft turned toward the Empress VOR. The controller interpreted this to mean that the aircraft was not yet receiving guidance information from the Calgary VOR and provided radar vectors to the flight.

Eastbound ACA3696 was at FL330 at a speed of mach 0.74, and the crew had been advised by ATC of weather east of their position. The flight crew consulted the aircraft's *Altitude and Manoeuvre Capability* charts to determine aircraft performance at a higher altitude. The manoeuvre capability weight is the weight at which the aircraft can sustain a positive acceleration (more than 1G) without the onset of an aerodynamic stall. From the charts, the maximum weight based on an acceleration of 1.4G was 112 000 pounds, and for a manoeuvre of 1.6G the maximum weight was 105 000 pounds. The estimated weight of ACA3696 at the time of the occurrence was 106 300 pounds.

The flight data recorder from ACA3696 was not recovered for this investigation. The flight deck crew recalled entering a bank angle of at least 45° during the evasive manoeuvre initiated after receiving the TCAS RA. The first officer held this bank angle until the captain commanded a descent in response to the buffeting. In level flight, a 45° bank turn can produce an acceleration up to 1.4G, and a 48° bank turn, 1.6G. The aircraft experienced buffeting during the manoeuvring. This buffeting was noted as very similar to a high-speed mach buffet and as very different from that caused by turbulence.

Both aircraft were equipped with functioning Mode S transponders and TCAS II equipment. This system is designed to give opposite commands to each aircraft during TCAS RAs. In this occurrence, ACA3696 received a climb advisory and ACA3627 received a descent advisory. ACA3696 turned and descended, and ACA3627 descended straight ahead.

The ACA3696 flight crew had received initial and recurrent TCAS academic training in the form of computer-based instruction and review questions based on the manual for the model of TCAS installed in the 737. CAR Standard 725.124(9) indicates that for a Level A training program, training in standard operating procedures for normal, abnormal, and emergency operation of TCAS shall be carried out in an approved flight simulator where available. AIP, RAC 12.15.4, refers to the Transport Canada requirements for Canadian operators using TCAS / ACAS II. These requirements and standards are those specified in the US Federal Aviation Administration Advisory Circular No. AC120-55A, as amended. The circular specifies that initial and recurrent training should include manoeuvre training. This training can be accomplished in a suitably equipped flight simulator or with an approved computer-based program.

The Air Canada training profile for the 737 simulator program states that TCAS RA manoeuvres are to be performed every third training session. Simulator training is the primary means for conducting training; however, written questions, briefings, computer based training, or video presentations may be used in lieu of or in conjunction with simulator training. These training sessions occur every six months at a maximum. Air Canada has two 737 simulators that Transport Canada has approved for training. The simulator in Toronto, Ontario, does not have TCAS installed, and flight crew there do not receive simulator-based training for TCAS manoeuvring. The simulator in Vancouver does have TCAS installed; realistic TCAS simulations can be performed, with some coordination with the simulator technicians, when available. The flight crew of ACA3696 trained primarily in Toronto and received no practical TCAS flight manoeuvre training in a flight simulator, although none was required by the training standard.

At the time of the occurrence, the Calgary en route specialty staffing was in accordance with unit policy. The supervisor was controlling during the occurrence, and the traffic in the Alsask sector was described as moderate. The controller was working alone at the Alsask sector, without a data controller, and had been at the

console for approximately one hour at the time of the occurrence. The controller was aware of the potential conflict between the two Air Canada flights and had planned that sufficient lateral separation would exist. The clearance to ACA3627 to go direct to the Calgary VOR would have provided at least 20 nautical miles of lateral spacing between the two aircraft, where 5 nautical miles separation was required.

On 31 August 2000, the TSB recommended (A00-15) that Nav Canada commit, with a set date, to the installation and the operation of an automated conflict prediction and alerting system at the nation's ATC facilities to reduce the risk of midair collisions. Nav Canada began testing of an ATC conflict-alert system on 31 March 2001 at the Toronto ACC. However, testing has since been interrupted because of technical difficulties. Further tests are scheduled beginning in March 2002.

Analysis

It could not be determined why the captain of ACA3627 turned toward the wrong VOR. With the first officer removed from the situation while getting weather on the second VHF radio, the ability to verify ATC clearances—an effective defence against pilot misunderstanding of ATC communications—was removed. The pilot flying did not ensure that the navigation aid frequency selected before turning on course direct to what he thought was Calgary was, in fact, the Calgary VOR. The same mistake had been made earlier in the flight when the pilot allowed the aircraft to turn toward Empress VOR instead of the cleared track to Calgary. The first mistake, detected at the time by the controller, was assumed by the controller to have been the result of not accurately receiving the navigation aid rather than having the wrong frequency selected. Radar vectors were then provided to ACA3627 to ensure that it would remain north of the track of ACA3696.

ACARS effectively allows both pilots in an aircraft to operate on the same voice frequency, even while receiving or sending information. As is common, ACA3627 did not have an ACARS installed. However, not having ACARS removed the redundancy of both pilots checking the appropriate clearance and set-up of the navigation equipment.

The captain of ACA3627 did not read back the ATC clearance, nor did the controller request a readback; thus, a viable defence to prevent errors in the communication process was removed.

After the controller issued the clearance to ACA3627, several communications were made that required much of the controller's attention. In addition to his flight control and monitoring functions, the radar controller was performing duties that could have been performed by a data controller. This increased workload might have prevented the controller from monitoring the aircraft's compliance with the instruction to fly direct to Calgary and from immediately noticing the course deviation toward the Empress VOR. A conflict-alerting feature in the radar situational display would have provided a valuable defence during this period of increased workload.

The crew of ACA3696 was aware of the reduced separation as it developed and commenced a pre-emptive turn to the right to increase the distance from the intruder. The captain did not follow the TCAS RA to climb, but rather commanded an increase in the bank angle because the aircraft was established in a turn away from the intruder. Due to the aircraft's heavy weight and the aerodynamic load in the turn, the aircraft began to experience the onset of an aerodynamic stall, signified by the buffeting. This buffeting, coupled with the descent initiated by the flight crew, caused the cabin crew and the passengers to lose their footing and to strike the ceiling and the floor of the cabin.

Findings as to Causes and Contributing Factors

1. ACA3627 turned toward the Empress VOR (very high frequency omnidirectional range) rather than the Calgary VOR as cleared, because the captain did not ensure that the correct navigation facility was selected. ACA3627 thereby flew directly toward ACA3696, which was at the same altitude, compromising the safety of flight.
2. Because of a momentary high workload, the controller was not able to monitor his separation plan and, therefore, did not detect in sufficient time that ACA3627 had deviated from the intended course.

Findings as to Risk

1. The ACA3696 captain decided to steepen the turn and then descend in response to the aerodynamic buffeting, rather than follow the traffic alert and collision-avoidance system (TCAS) resolution advisory (RA) instruction to climb. This decision increased the risk of a midair collision with ACA3627, which was also descending as a result of the coordinated TCAS RA.
2. The 737 simulator in Toronto is not equipped with TCAS. The ACA3696 flight crew was trained in that simulator and did not benefit from applying their TCAS knowledge to simulated avoidance manoeuvres.
3. ACA3627 was cleared to an altitude inappropriate for the direction of flight, placing it at the same flight level as ACA3696.
4. The captain of ACA3627 did not read back the air traffic control clearance to proceed to the Calgary VOR, nor did the controller request a readback; thus, a viable defence to prevent errors in the communication process was removed.
5. Nav Canada radar situational displays are not equipped with conflict-alert software.

Safety Action Taken

On 19 October 2001, the TSB sent Aviation Safety Information Letter A010032-1 to Air Canada regarding the lack of practical traffic alert and collision-avoidance system training available to flight crews training in Toronto.

Nav Canada will be conducting operational trials of the latest version of conflict alert software in Moncton Area Control Centre starting in March 2002.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 04 March 2002.