AVIATION INVESTIGATION REPORT
A00P0199

HAZARDOUS SITUATION—ATC IRREGULARITY

NAV CANADA
VANCOUVER AREA CONTROL CENTRE
VANCOUVER, BRITISH COLUMBIA
08 OCTOBER 2000

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

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Summary

Horizon Air QXE260, a de Havilland Dash 8, was on an instrument flight rules flight plan to Vancouver International Airport, British Columbia, arriving from the south via the Acord 9 arrival for an instrument landing system approach to Runway 08L. Air traffic control (ATC) instructed QXE260 to leave the Vancouver VOR (very high frequency omnidirectional radio range) on a heading of 340°. About 1 minute 20 seconds later, ATC cleared the flight to maintain 5000 feet above sea level. This heading and altitude resulted in the aircraft tracking north of the airport toward higher terrain where the minimum vectoring altitude (MVA) was 7000 feet. The controller then became involved with coordinating other aircraft for the approach and forgot about QXE260. The controller was alerted to the position of QXE260 by his coordinator. The controller issued a series of instructions to the flight crew that essentially involved a tight left turn and climb to 7000 feet. The aircraft was climbing a couple seconds after entering the 7000-foot MVA area at 5000 feet. The aircraft reached 7000 feet 1 minute 15 seconds later, just before exiting the MVA area. QXE260 was in instrument meteorological conditions at all times and landed on Runway 08L without further incident.

Ce rapport est également disponible en français.

Other Factual Information

The Vancouver Acord 9 arrival is a standard arrival routing, commonly used for aircraft landing at Vancouver, British Columbia, from the south; the routing is depicted as a chart in *Canada Air Pilot*. (See Appendix A.) According to information on the chart, aircraft planning to land on Runway 08L/R are to cross the Vancouver VOR (very high frequency omnidirectional radio range), fly westbound on the 264° radial, and be vectored thereafter to the runway final approach course. The Vancouver VOR 264° radial approximates a right-hand downwind circuit leg about seven nautical miles south of the airport. The instrument landing system chart for Runway 08L contains the statement "radar required", which indicates to the pilot to expect vectors (heading and altitude) during the approach.

Depending on traffic demands, controllers vector some aircraft over the airport to the north for a left-hand downwind to Runway 08L. This procedure is described as a crossover. The chart does not indicate that an aircraft may be vectored north, toward high terrain. As a result, pilots may not plan for other routings that take into account the high terrain or additional navigation requirements. The Acord 9 arrival chart only depicts minimum vectoring altitude (MVA) areas and minimum safe-altitudes for specific route segments. When an aircraft is in instrument meteorological conditions and on vectors, the flight crew has to rely entirely on the controller for terrain clearance, regardless of the capabilities of current ground proximity warning systems (GPWSs).

In accordance with sections 1.5.2 and 1.5.5(a) of Rules of the Air and Air Traffic Services (RAC) in Transport Canada's *Aeronautical Information Publication*, air traffic control (ATC) will ensure that the appropriate obstacle clearance is provided when an aircraft is being radar vectored. When the controller issued the crossover vector to QXE260, he did not issue instructions for the flight crew to take some predetermined action if they did not receive further instructions in a timely manner or in the event of a communications failure. In this phase of flight, it is normal for the flight crew to set their navigation aids to the instrument landing system frequency and headings for the final approach course to the runway. They then rely on controller-issued vectors to transition from the en route phase to intercept the final approach. Being in instrument meteorological conditions, the flight crew could not visually assure their own terrain clearance. Neither Nav Canada's *Vancouver Terminal Operations Manual* nor the *Air Traffic Control Manual of Operations* provide safeguards for controllers' use to alert themselves of an aircraft that will require immediate further attention.

The DHC-8-200 aircraft was equipped with a GPWS that would have warned the crew of an excessive closure rate to terrain. The GPWS activates when the electrical system is powered and can only be deactivated under certain approved conditions. Continuous flight path surveillance is provided when the aircraft is operating between 50 feet and 2450 feet above ground level. No action by the flight crew is required unless a warning is activated. The GPWS was operating for the flight; it did not activate a warning during this occurrence.

The equipment used by the arrival controller included a radar data-processing system (RDPS) situational display (RSiT). The system does not incorporate a minimum safe-altitude warning (MSAW) system to warn controllers of an aircraft flying below an MVA.

Because of staffing shortages on the day of the occurrence, the Vancouver terminal specialty arrival high and arrival low sectors were combined, and the flow rate into Vancouver International Airport was set at 28 instrument flight rules (IFR) arrivals per hour. It was expected that additional staff would arrive later in the morning, which allowed the flow rate to be set at 36 IFR arrivals per hour starting at 1030 Pacific daylight

time.[1] The shift supervisor, in conjunction with the shift manager, is responsible for establishing the IFR arrival flow rate for the Vancouver terminal.

At 1017, the time of the occurrence, Vancouver arrival was staffed by a trainee and an on-the-job instructor (OJI). The trainee was performing the control functions; however, the OJI was responsible for the position. Published procedures direct that the OJI must have direct access to all communications in the event that an immediate take-over of the position is required. Because the trainee was at an advanced stage of his training program, the OJI had been standing back to allow the trainee to work without interruption.

The trainee vectored QXE260 overhead the airport via an assigned heading of 340° from the Vancouver VOR, with a descent to 5000 feet. This heading resulted in the aircraft tracking toward higher terrain north of the airport, at an altitude that would be below the progressively higher MVA for that area. Controllers can and do issue a heading of 320° or less from overhead the Vancouver VOR to ensure that an aircraft remains west of the 7000-foot MVA area.

The OJI and the trainee then became involved with the coordination of two other aircraft that were on vectors for Runway 08L. Both controllers were focused on discussing these aircraft to the extent that they forgot QXE260. They had not used a reminder or memory aide, such as a cocked flight progress strip, projected track line, halo, request for position reports from the flight crew, or alternate instructions to the flight crew. The coordinator's warning to the OJI drew the attention of the two controllers back to QXE260 as it approached the boundary of the higher MVA area. The trainee issued a quick series of instructions to QXE260, first to turn left to 240°, then to 180°, and then to climb to 7000 feet immediately. The trainee did not use the phraseology published in *Air Traffic Control Manual of Operations* for issuing a safety alert to the aircraft. QXE260 penetrated the 7000-foot MVA area by approximately 3 nautical miles as the aircraft turned to the westbound heading.

The OJI and the trainee were removed from duty in accordance with Nav Canada procedures. The shift supervisor had to be recalled from a break to fill the position because the unit was short-staffed at the time of the occurrence.

According to section 206(a) of Vancouver Terminal Operations Letter dated 30 September 1999, directed at Vancouver east specialty controllers, any aircraft being vectored toward higher terrain at an altitude below the higher terrain shall not be brought any closer than 2 nautical miles from the higher terrain boundary while still pointed at the higher terrain.

Vancouver Area Control Centre Operations Bulletin (a temporary document) 00-135, issued 10 July 2000, addresses assigning MVAs that are below published minimum IFR altitudes and discusses the requirement for alternate instruction under some circumstances. However, the bulletin offers no solutions other than for controllers to exercise caution when vectoring toward higher terrain, nor does it provide specific guidance on the type of alternate instructions to be issued.

MSAW systems were initially developed in 1976. These systems warn an air traffic controller that an aircraft is too close or is projected to be too close to terrain. MSAW systems alert the controller with both a visual and an aural alarm when an aircraft penetrates or is predicted to penetrate a predetermined altitude. In the United

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[1] All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

States, MSAW service is provided for all aircraft operating under IFR and, upon request, for aircraft under visual flight rules. When the MSAW system detects a potentially unsafe condition, the controller alerts the flight crew. Nav Canada has not yet implemented an MSAW system. In its *Corporate Safety Plan 1998/1999*, Nav Canada expressed its commitment to "the national installation of minimum sector altitude warning systems/conflict alert (MSAW/CA) on existing surveillance systems." The current RSiT software can be programmed to alert controllers that an aircraft has strayed into an active alert or restricted area. This capability could be adapted to provide MSAW; however, MSAW capability has not been implemented at any Nav Canada-owned facility.

Analysis

The practice of vectoring arriving aircraft to the north of the airport directly toward the high terrain requires controllers to pay careful attention to the position of those aircraft. Distractions during this particularly critical phase of flight, where an aircraft is headed toward high terrain, increases the risk of a controlled-flight-into-terrain accident. With no automated or manual alerting system, a lapse in memory and diversion of the two controllers' attention resulted in an aircraft—flying in instrument meteorological conditions—penetrating an MVA area where the aircraft was required to be at least 2000 feet higher than it was. The timely warning from a controller working at the coordinator position might have prevented a controlled-flight-into-terrain accident.

The OJI has the overall responsibility of ensuring that the ATC service provided by the trainee is safe. The OJI must maintain an overall situational awareness and resist the temptation to focus on any one area to the detriment of other traffic. The desire to assist the trainee with other aircraft on approach resulted in both controllers losing awareness of QXE260's position in relation to the terrain.

Although the Vancouver Area Control Centre management has generated a number of operations bulletins regarding the use of MVA, the distribution was limited to those specialties in which the situations occurred. The potential safety benefit of wide distribution of lessons learned from occurrences and the resulting change in procedures was lost to controllers in other specialties. The bulletins had not been directed to or distributed at the Vancouver terminal specialty, and the two controllers were not aware of the safety issues raised by some of these bulletins.

The Acord 9 arrival chart does not specify that an aircraft may be vectored to the north of the airport, neither does it provide information regarding back-up procedures or high terrain. This absence of information reduces aircrews' abilities to maintain their own situational awareness. Issuing vectors in areas restricted by terrain will continue to result in a risk of controlled-flight-into-terrain accidents unless the vectors are formalized to ensure standardization and the incorporation of safety defences, including dissemination of pertinent information to pilots.

Findings as to Causes and Contributing Factors

1. The controller instructed QXE260 to fly a heading that required further action within minutes to ensure that the required separation from high terrain would be maintained.

2. The controllers, distracted by other controlling duties, forgot that QXE260 was on a vector toward higher terrain. The aircraft entered a minimum vectoring altitude area 2000 feet below the required altitude of 7000 feet.

3. The controllers did not use memory aides as a safeguard in the event that their attention was diverted to other duties.

Findings as to Risk

1. The Acord 9 arrival chart does not indicate that an aircraft may be vectored to the north of the airport toward high terrain. This absence of information could reduce flight crew preparedness and situational awareness as a defence regarding their position in relation to the terrain.

2. The Acord 9 arrival chart and the approach plate for Runway 08L do not depict a navigational limitation to the north of the airport to ensure that aircraft do not stray into a high-terrain area. Without this information readily available, the defence of back-up procedures to increase a flight crew's situational awareness is compromised.

3. There is no operational minimum safe-altitude warning system to provide a technical back-up warning for controllers when an aircraft flies into an area of higher terrain.

Safety Action Taken

Vancouver Area Control Centre (ACC) issued Operations Bulletin 00-186 immediately after this occurrence. The bulletin indicated that if controllers use the centre-field crossover for flights from the south, aircraft shall not normally be cleared below 7000 feet until observed (on radar) in the downwind turn. If further descent is required on the northbound heading before issuing the downwind turn, the aircraft is to be instructed to intercept the Pitt Meadows VOR 260° radial to ensure that the aircraft does not stray into a high-terrain area.

In Operations Bulletin 00-188, issued 18 October 2000, the Vancouver ACC re-emphasized controllers' responsibility to follow *Air Traffic Control Manual of Operations* 507.1 ("Issue a safety alert to an aircraft if you are aware the aircraft is at an altitude which, in your judgment, places it in unsafe proximity to the terrain, an obstruction or another aircraft.")

In Operations Bulletin 00-189, issued 21 October 2000, the Vancouver ACC cautioned controllers to be extra vigilant to those clearances that are critical to maintaining separation or avoiding flight into high terrain.

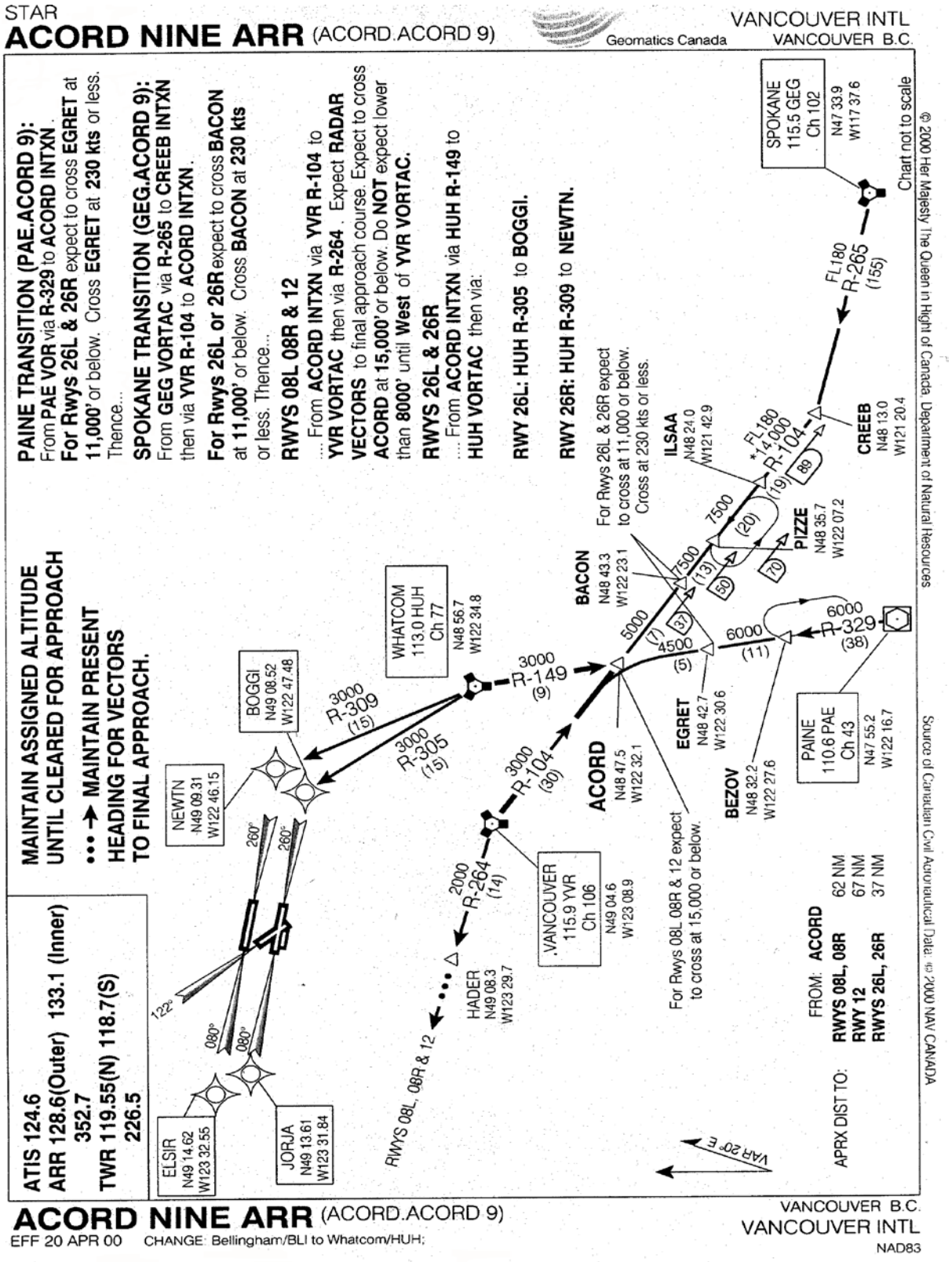
On 17 August 2001, the TSB forwarded Aviation Safety Information Letter A010018 ("Vancouver Acord Star Procedures") to Nav Canada. The letter points out the increased risks associated with the use of unpublished procedures and the lack of relevant pilot navigation information regarding the crossover procedure on the Vancouver Acord arrival chart. In response to this letter, Nav Canada has revised the Vancouver Acord Star procedure. As of 20 September 2001, two procedures became effective: the Acord Star for runways 08R, 08L, and 12 and a new procedure, the Whatcom Star, for runways 26L and 26R. The Acord Star now contains a cautionary note to pilots regarding high terrain to the north of the Pitt Meadows (YPK) VOR 260° radial and depicts the location and frequency of the YPK VOR and the 260° radial. The revised procedures were incorporated into the 01 November 2001 issue of *Canada Air Pilot*.

On 06 September 2001, Vancouver ACC management issued a staff memorandum in the ongoing effort to brief controllers on their responsibilities as on-the-job instructors.

Vancouver ACC management and the technical training department have added a module to the on-the-job instructor workshops regarding the extra vigilance required while training.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 February 2002.

Appendix A—CAP Acord Nine Arrival Chart



Appendix B—Radar Track and Vancouver Airport Area