Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

A98P0018

OPERATING IRREGULARITY

AIR BC LTD.
BRITISH AEROSPACE BAE146 FLIGHT ABL814
VANCOUVER, BRITISH COLUMBIA 30 nm N
01 FEBRUARY 1998

Canada

Aviation Occurrence Report

Operating Irregularity

Air BC Ltd.
British Aerospace BAE146 Flight ABL814
Vancouver, British Columbia 30 nm N
01 February 1998

Report Number A98P0018

Summary

Flight ABL814, an Air BC BAE146, serial number E2121, was cleared from Prince George, British Columbia, to Vancouver International airport at flight level 270 via J541 to BRYGE with a SKYPO Eight arrival. During the flight, the en route air traffic controller inadvertently cleared the aircraft to descend to an altitude that was below the minimum vectoring altitude (MVA) for the area. The MVA is the lowest altitude that meets obstruction clearance requirements in the specified airspace, and is the lowest altitude that Transport Canada has approved for vectoring of aircraft by air traffic control (ATC). The crew of ABL814 accepted the clearance and descended. By the time the controller recognized the problem, the aircraft had descended below radio coverage and could not be contacted directly using NAV CANADA's ground-based communications network. An aircraft in an adjacent control sector relayed the ATC instructions for ABL814 to climb. The crew of ABL814 received the relayed message, climbed to a safe altitude, and continued on to Vancouver. The weather was clear at the time of the incident, and the terrain was plainly visible to the crew; there was no risk of collision with the terrain.

Ce rapport est également disponible en français.

Other Factual Information

The en route controller had just returned to the area control centre (ACC) operations room following a scheduled half-hour break and was working alone at the sector. Traffic in his sector was light; the controller had only ABL814 on his radar display. He had accepted an early handoff on that aircraft when it was about 20 nautical miles (nm) north of his sector, and he was monitoring its progress toward the Vancouver Terminal Area. Vancouver Terminal then informed the en route sector controller, who in turn informed ABL814, that there would be a flow delay of four minutes. The en route controller directed ABL814 to reduce speed from Mach 0.65 to Mach 0.62, and he monitored the aircraft's progress to confirm that the new speed would create the required delay. When the controller re-calculated the estimate, he determined that the aircraft was still going to be early. He then cleared ABL814 for the SKYPO Eight Arrival, to maintain 14 000 feet above sea level (asl) and 250 knots. His plan was to have the aircraft descend early and issue the speed restriction in order to reduce the aircraft's speed over the ground and thereby achieve the required delay; ABL814 descended in accordance with the clearance. The controller completed another calculation, which confirmed that the aircraft's lower speed at the lower altitude was resulting in an appropriate delay.

The en route controller's radar display includes a number of maps and overlays. Of direct significance are two separate MVA lines that indicate the demarcation between different MVA areas within the controller's airspace. Both lines are similar in design, colour, orientation, and function to other lines on the display depicting MVA boundaries, but each represents a different altitude restriction; the north line marks the boundary of a 14 000-foot MVA, while the south line indicates the beginning of an 11 000-foot MVA. Under normal conditions, aircraft cleared for en route descents into Vancouver cross the north MVA line at an altitude between 16 000 and 17 000 feet asl. Similarly, aircraft tend to cross the south (second) MVA line at about 14 000 feet asl, at which time the controllers routinely issue further descent clearance to 11 000 feet asl. Controllers become accustomed to this standard descent profile, and there could develop a tendency to give the associated clearances as a matter of habit rather than as a cognitive action. There is no independent means for aircrew to cross-check MVA boundaries with published information available in the aircraft.

As ABL814 approached the northern 14 000-foot MVA line, the en route controller informed the crew that he would have a lower altitude for them in five miles. Several minutes later, as the aircraft crossed into the 14 000-foot MVA area, the controller inadvertently cleared the crew to descend to 11 000 feet asl. The controller then began preparing for the next action associated with this aircraft; that action would be to pass control of the aircraft to the arrival controller. In preparation, he increased his visual scan on his radar display, away from the aircraft, and south of the MVA line, and immediately realized that he had descended the aircraft in error.

ABL814 was descending through about 13 000 feet asl when the en route controller first attempted to clear the aircraft back up to 14 000 feet asl. However, by this time, the aircraft was below the communication coverage for the area and the pilot did not hear the transmission; he continued his descent and levelled off at 11 000 feet asl. The controller tried to contact the aircraft several times using transmitters located at both Kamloops and Vancouver but was unable to contact the crew from either site. The controller then moved to another en route controller's workstation and requested that controller to contact any aircraft in the vicinity in order to relay an instruction for ABL814 to make an immediate climb.

Meanwhile, the crew of ABL814 had reported level at 11 000 feet asl on the ATC frequency but had not heard a response from the en route controller. The aircrew was familiar with this particular route and were aware that there were a number of dead zones in the communication coverage north of Vancouver. Their response was to continue inbound at 11 000 feet asl and to change their radio frequency to the Vancouver arrival frequency to request further direction. The Vancouver arrival controller heard the aircraft's transmissions on the arrival frequency, but he was unaware of the communication problems being addressed in the en route sector. Because ABL814 was outside arrival's airspace, the controller directed the aircraft to return to the previous en route frequency. ABL814 complied with that direction and eventually heard another pilot relay the instructions to climb.

A direct controller-pilot communication (DCPC) is a two-way radio communication between a controlling air traffic control unit and an instrument flight rules (IFR) aircraft that is under its control, without resort to a relay through another unit. The ATC manual of operations (MANOPS) requires that, when a controller is unable to maintain two-way radio communication with an IFR aircraft, the controller take action to separate other aircraft from the aircraft having the communication failure and to attempt to regain communication. The specific procedures used by ATC are based on an underlying assumption that the aircraft crew will follow rules laid out in *Canadian Aviation Regulations* (CAR) and procedures described in the *Canada Air Pilot* and the *Canada Flight Supplement* (CFS). These procedures require that, if a communication failure occurs in visual meteorological conditions (VMC), the pilot shall continue the flight under visual flight rules (VFR) and land as soon as practicable. If the communication failure occurs under instrument flight conditions (IMC), while the pilot is being vectored at an altitude that is lower than a published IFR altitude, the pilot shall immediately climb to and maintain the appropriate minimum IFR altitude. In both cases, the procedures require the pilot to select the transponder to reply on Mode 3/A code 7600; this code is the internationally recognized signal that an aircraft is experiencing a communications failure and, when received by the NAV CANADA RAMP radar system, audio and visual warning are set off in the area control centre (ACC). In this occurrence, the aircraft was operating in VMC, and the pilot continued in visual conditions while attempting to re-establish communications on an alternative frequency. There is no clear definition for the term "communication failure" in applicable publications, and the pilot did not select code 7600.

The ATC MANOPS also states that, as appropriate, the controller should inform adjacent ATC units of the details of a communication failure and request that all units attempt to contact the aircraft. At the time of this occurrence, the arrival controller, who handles an adjacent airspace, was physically separated from the en route controller's workstation and was not informed of the communication problem. The en route controller had chosen as his first action to advise another en route controller of the problem and request that an aircraft relay climb instructions to ABL814.

Radar vectoring charts are developed for areas which require numerous minimum vectoring altitudes because of variable terrain features. These charts are designed to ensure that all the listed MVAs meet the obstacle clearance requirements of Transport Canada's publication TP 308 *Criteria for the Development of Instrument Procedures*. MVA charts do not require flight inspection certification, and TP 308 makes no direct mention of a specific requirement for communication capabilities either at or below the MVA.

In the Vancouver area, the MVA charts are developed, monitored, and changed as necessary by NAV CANADA's Telecommunication Project Engineering Branch. This MVA chart design is based on the theoretical coverage of the available radar network; the altitudes on the charts are not flight-tested to validate this radar coverage. Additionally, the MVA charts do not take into account the area's actual or validated communication system coverage.

CAR 602.124 defines the pilot's responsibility with respect to obstacles and terrain clearance during flight, and restricts a pilot from descending below certain published minimum altitudes except when on radar vectors.

However, Vancouver ACC controllers routinely assigned an 11 000-foot altitude to inbound aircraft flying the SKYPO Eight Arrival; this altitude is based on an MVA chart for the area and is below the published minimum altitude for that route segment. Supervisory staff in the ACC indicated that it is an accepted local procedure to treat a standard instrument arrival as a vectoring procedure thereby allowing controllers to assign these lower altitudes which are based on the MVA charts. This procedure appears to be inconsistent with CAR 602.124, which specifically disallows a pilot from accepting these altitude assignments unless on a radar vector. Following this occurrence, Transport Canada indicated that, notwithstanding the direction of CAR 602.124, ATC may, once the aircraft is radar identified and under radar control, assign an MVA without specifically issuing a radar vector. This is accomplished with the clear understanding by ATC that the responsibility for obstacle clearance resides with ATC just as if ATC had issued a radar vector with the MVA assignment. Transport Canada recognizes that CAR 602.124 needs to be amended to reflect this operational application of assigning MVAs to an aircraft that is radar identified and under radar control and is taking action to change that regulation.

Controllers and aircrew alike have noted that there are areas in the approaches to Vancouver where communication is temporarily lost because of blocking by high terrain. Local solutions to this problem have developed informally; controllers tend not to vector aircraft into areas where communications are known to be weak, and pilots tend to accept the temporary loss of communication as a routine and non-emergency situation. Pilots often find that, by waiting several minutes, or by changing to the next ATC sector's frequency, communications will be re-established.

Controllers' expectations are based largely on their mental models of their sectors and the flow of traffic through this airspace. In general, an accurate mental model allows a controller to properly plan and manage the sector. Radar is the primary aid used to control traffic in this area, and all the relevant information presented on the radar display must be scanned continuously. As a controller's experience in a particular sector increases, the cues that are used to anticipate action become more subtle. In the en route sector, under normal traffic conditions and with a handoff in a customary position, the time that each aircraft remains on the controller's radar display is relatively constant, and the controller may tend to anticipate action based on the passage of time. Similarly, because an aircraft's descent profile is similar from day to day, some controllers may tend to perceive cues about the aircraft's horizontal progress from the aircraft's altitude read-out on the radar display. These relatively subtle cues tend to build into powerful mental models that will directly influence the controller's expectations.

Minimum safe altitude warning (MSAW) systems were initially developed in 1976. These systems have the capability to warn an air traffic controller that an aircraft is either 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 either penetrates or is predicted to penetrate a predetermined altitude. In the United States, MSAW service is provided for all aircraft operating under IFR and is provided when requested by aircraft operating under VFR. When a potentially unsafe condition is detected by an MSAW system, the controller alerts the flight crew. NAV CANADA has not yet implemented an MSAW system. All seven Canadian ACCs, including the Gander Oceanic Area Control Centre (OACC), the single stand-alone Terminal Control Unit facility at Ottawa, Ontario, and 23 control towers are equipped with systems that have the capacity to compute and display MSAW alerts; however, this capability is not yet implemented because the certification process and operational training for controllers are not complete. NAV CANADA has recently stated that the MSAW portion of the next software release was not included in the site test procedure scheduled for the spring of 1999. At the same time NAV CANADA, in its Corporate Safety Plan 1998/1999, continues to express the fact that it is committed to "the national installation of Minimum Sector Altitude Warning Systems/Conflict Alert (MSAW/CA) on existing surveillance systems."

Analysis

A light traffic load in the en route sector influenced the controller to concentrate his visual scan on the one aircraft being controlled. This concentration on one area of the radar display reduced the controller's ability to maintain full situational awareness as to the position of this flight in relation to the various lines depicting different MVA boundaries. As ABL814 approached the 14 000-foot MVA line on the controller's radar display, the aircraft was well below the usual 16 000- to 17 000-foot altitude associated with that line and was levelling at an altitude that is normally associated with an aircraft approaching the 11 000-foot MVA line. At the time he made the error, the controller was focussed on the aircraft target. He saw that the aircraft was approaching an MVA line, he knew that he had already given a descent clearance to 14 000 feet asl, and he recognized from the altitude display that the aircraft was levelling at that altitude. When the aircraft crossed the MVA line, the controller gave the next step-down clearance to an altitude of 11 000 feet asl; this was done out of habit and without realizing that the aircraft was actually further north than normal and entering the 14 000-foot MVA area. After clearing the aircraft to 11 000 feet asl, the controller increased his range of visual scan in preparation for handing off the aircraft to the arrival controller. It was at that point that he realized the aircraft's position was much further north than expected.

The crew of ABL814 was unaware of the controller's error and accepted the clearance and descended to the altitude issued by the controller, which was below the MVA for the area in which the aircraft was flying. This action was not in accordance with the CAR, but was consistent with a control procedure that was being used routinely by the Vancouver ACC, and that had been approved for use by Transport Canada. When operating below published minimum altitudes, there is no independent means for aircrew to easily cross-check MVA boundaries with published information available in the cockpit; therefore, the crew's ability to recognize or compensate for the controller's error was greatly reduced.

The crew's response to the loss of direct controller-pilot communication, after levelling at 11 000 feet asl, was influenced by the fact they were operating in VMC. Based on the pilot's knowledge of the area north of Vancouver, he had come to expect sporadic radio coverage in the high terrain and, because these communication difficulties were normally encountered and therefore anticipated, he did not consider them to be valid communication failures. As a result, his motivation to initiate the loss of communication procedures published in the CFS was reduced.

The arrival controller was not informed of the communication problem being attended to in the en route sector. Had the en route controller anticipated that the aircrew would try to contact the next sector on its route of flight and had the arrival controller known about the problem, the arrival controller could have directed the aircraft to climb immediately on initial contact.

MVAs are non-published minimum IFR altitudes to which a pilot cannot make reference in the cockpit. Accepting an MVA when that aircraft is not being radar vectored can lead to confusion about whether the pilot or the controller has responsibility for obstacle and terrain clearance. Additionally, an error by the controller in assigning an incorrect altitude cannot be cross-checked by the pilot, and could result in an aircraft descending below a minimum IFR altitude. Local interpretation of existing rules and procedures can lead to an erosion of the defences designed to provide minimum acceptable obstacle and terrain clearance for aircraft in flight.

Another defence, which would have alerted the controller much sooner to the descent by ABL814 below the minimum IFR altitude, would have been MSAW. This system, already available in other ATC systems worldwide, and slated to be installed as part of the RAMP radar as early as 1990, is still not available to aircraft flying in civil controlled airspace in Canada. NAV CANADA has not been able to deploy this capability to date.

Findings

1. The en route controller accepted an early radar handoff on ABL814 when the aircraft was about 20 nautical miles north of his sector; this increased the time the aircraft was under his control.

2. The en route controller descended the aircraft early to facilitate a four-minute flow delay required by the terminal specialty; this early descent modified the aircraft's approach profile and lowered its crossing altitudes over two MVA lines.

3. When ABL814 crossed the en route sector's 14 000-foot MVA line, the en route air traffic controller inadvertently cleared the pilot to descend to 11 000 feet asl, an altitude that was appropriate for the southern MVA line.

4. There is no clear definition in applicable publications for the term "communication failure."

5. The Vancouver ACC was using an altitude assignment procedure which allowed controllers to assign altitudes that were below the minimum published IFR altitudes; Transport Canada had approved the use of this procedure.

6. The controller assigned an inappropriate MVA to an aircraft that was not being radar vectored.

7. The crew of ABL814 descended below the MVA as directed; there is no way for the aircrew to cross-check the MVA boundaries.

8. An MSAW system is designed to alert the controller of an error; NAV CANADA has not yet implemented this type of independent warning into its control system.

9. The controller's attempts to recover from the error were impeded by a lack of direct controller-pilot communications capability because of the aircraft's low altitude; specifically, ABL814 could not be contacted directly using NAV CANADA's ground-based communications network.

10. The crew of ABL814 routinely lost radio coverage when approaching Vancouver and, therefore, were not predisposed to implement the lost communication procedures as prescribed in the *Canadian Aviation Regulations* (CAR).

11. The Vancouver arrival controller, who handles the adjacent airspace, is physically separated from the en route controller's workstation, and he had not been informed of the communications problem being addressed in the en route sector.

12. The arrival controller received a transmission from ABL814 but, because he was unaware of the communication problem, directed the crew to return to their previously assigned en route frequency.

13. MVA charts do not require flight inspection certification and TP 308 makes no direct mention of a requirement for direct pilot-to-controller communication capabilities either at or below the MVA.

14. Weather at the time was VMC.

15. There was no risk of collision with terrain because the crew could see the mountains.

Causes and Contributing Factors

The controller inadvertently cleared ABL814 below the MVA, and the crew accepted the clearance. Contributing to this occurrence were the lack of direct controller-pilot communication capability because of the aircraft's low altitude, and a reduced motivation by the flight crew to respond to the loss of communication because of the routine nature of this event.

Safety Action

NAV CANADA is aware of the communication problems north of Vancouver and is installing a new transmitter on Saltspring Island to increase the communication coverage in that area.

Air BC requested a copy of the MVA charts for Vancouver and has made this information available to its flight crews to increase their general knowledge.

TP 308 is currently under revision; the new edition will specify that MVAs must include sufficient communications coverage to permit direct controller-pilot communication (DCPC) at all times.

Transport Canada notes that increasing emphasis is being placed on allowing aircraft to self-navigate along published routes, especially in terminal areas. Because of these evolutions in operational procedures, Transport Canada has indicated that a literal application of CAR 602.124 in its current form would place severe operational restrictions on both air traffic controllers and pilots. Transport Canada intends to submit a Notice of Proposed Amendment (NPA) on CAR 602.124 to include the notion of MVA application as it is currently being practised.

The Board is concerned that NAV CANADA has no MSAW/CA installation dates assigned to its Corporate Safety Plan 1998/1999, notwithstanding NAV CANADA's ongoing commitment to the program.

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 22 September 1999.