Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A01P0171

LOSS OF SEPARATION AND RISK OF COLLISION

NAV CANADA

VANCOUVER AREA CONTROL CENTRE—NOOTKA SECTOR

KELSY INTERSECTION, BRITISH COLUMBIA

23 JULY 2001

Canada

Aviation Investigation Report

Loss of Separation and Risk of Collision

NAV Canada
Vancouver Area Control Centre—Nootka Sector
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Report Number A01P0171

Summary

The Voyageur Airlines de Havilland DHC-7 (VAL712) departed Masset, British Columbia, at about 1230 Pacific daylight time en route to Vancouver at 17 000 feet. A Cessna 421 (C-GKOS) departed Port Hardy at 1330 en route to Red Deer, Alberta. C-GKOS climbed eastbound initially to 15 000 feet and was subsequently cleared to maintain 17 000 feet. The two aircraft tracks converged near the KELSY intersection. Both flights were radar-identified in controlled airspace, flying in accordance with instrument flight rules, and provided air traffic control services by the Nootka radar controller in the Vancouver Area Control Centre (ACC). At about 1351, as C-GKOS approached the KELSY intersection, the Nootka radar controller verbally handed off the Cessna 421 to the Comox terminal controller. The Comox controller identified the handoff target but also questioned the proximity of another aircraft target, VAL712. The Nootka radar controller recognized the traffic conflict and instructed C-GKOS to maintain 15 000 feet. He then received a radio call from VAL712 about the proximity of C-GKOS. By then, the two aircraft had passed each other and were on diverging tracks. The two aircraft came within 0.8 nautical mile (nm) of each other at 17 000 feet. Visual meteorological conditions existed at the time.

Ce rapport est également disponible en français.

Other Factual Information

The KELSY intersection is a reporting point on V347 at the border of the Vancouver civilian airspace and the Comox military airspace, 51 nm east of Port Hardy, British Columbia.

At 1351:50 Pacific daylight time,[1] when VAL712 and C-GKOS were about 1.7 nm apart at 17 000 feet, the Nootka radar controller (the radar controller), prompted by the Comox controller, recognized the imminent risk of collision. At 1352:05 and again at 1352:17, the radar controller tried to instruct C-GKOS to descend to 15 000 feet. However, he twice used the call sign GKS rather than GKOS, and the pilot of C-GKOS did not respond to those instructions. At 1352:21, he used KOS, and the pilot immediately acknowledged the instruction to descend. The radar controller did not advise either aircraft of the other. Radar data show that C-GKOS began to descend from 17 000 feet about 40 seconds after the first transmission to descend.

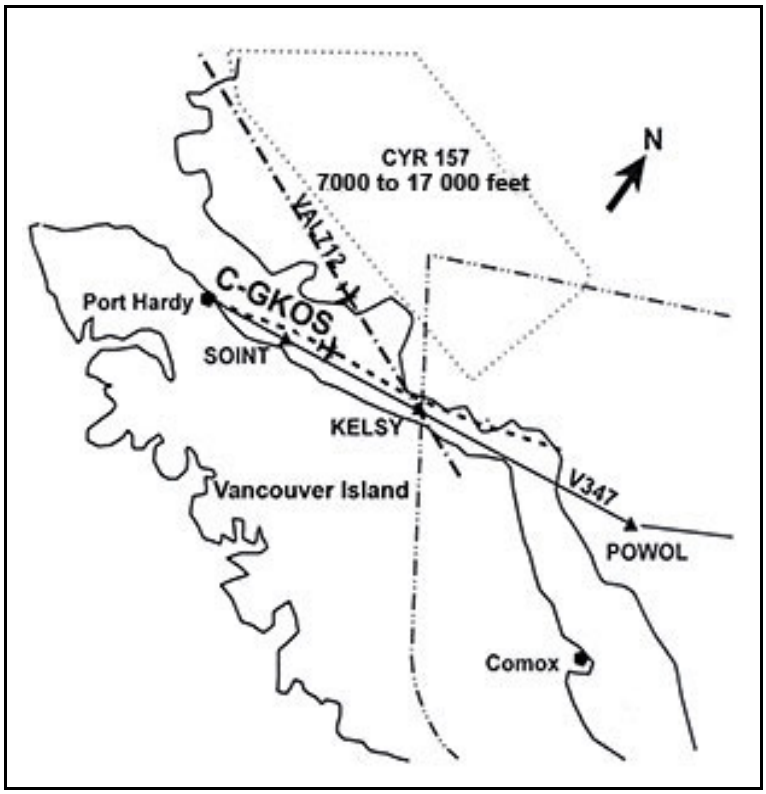

Figure 1. Relative flight paths of C-GKOS and VAL712

During his attempted transmissions to C-GKOS to descend to 15 000 feet, the radar controller did not convey a sense of urgency to the pilot, nor did he incorporate the standard published safety alert phraseology[2] to indicate a need to commence an immediate descent.

At 1352:40, the VAL712 pilot advised the radar controller that he had received a traffic alert from the on-board traffic alert and collision-avoidance system (TCAS) triggered by C-GKOS's crossing ahead of them; the VAL712 pilot had C-GKOS in sight. C-GKOS began to descend after these communications.

Air traffic control radar data show that the two aircraft were on a collision course of constant relative bearing until 10 seconds before the Comox controller advised the radar controller about the proximity of VAL712. At this point, the collision geometry began to change as C-GKOS increased its speed during normal climbout profile acceleration.

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

[2] NAV Canada, *Air Traffic Control Manual of Operations* 507.1—Safety Alert.

At the time of the incident, the workload for the Nootka positions (radar and data) in the West Complex of the Vancouver ACC was moderate, with normal complexity. The West Complex would normally have been staffed by seven controllers and one supervisor. At the time, the unit was staffed with eight controllers and no supervisor. Only six controllers were actually at their positions, however; the other two were on scheduled break. The Nootka sector was combined with the Holberg sector, and together they had a dedicated radar controller and a dedicated data controller. Given the traffic volume and complexity at the time, it was not unusual to combine the sectors.

In the 25 minutes before this incident, the radar controller had been in radio contact with 21 aircraft: 13 high-level aircraft offered no conflict; 5 low-level aircraft required action by him to ensure separation was maintained; and 3 low-level aircraft offered no conflict. The radar controller made about 45 radio transmissions during this period: only 11 were of a controlling nature; the rest were simple acknowledgements or frequency changes. Appendix A summarizes the chronology of main events for the 20 minutes preceding the incident.

In the 6 minutes between the radar controller's clearing of C-GKOS to maintain 15 000 feet (1335:09) and the subsequent clearance to 17 000 feet (1341:24), 3 radio acknowledgements, 3 handoffs, and one period of 3.5 minutes of uninterrupted silence occurred. During this time, C-GKOS was the only aircraft changing altitude. In the 5 minutes before the Comox controller pointed out the conflict with VAL712 (1351:42), the radar controller was actively involved with managing N199BB's departure and climbout of Port Hardy, PCO807's arrival and setup for an approach to Port Hardy, and C-GKOS's climb en route.

This incident occurred in the Nootka sector airspace (Figure 1), which is adjacent to military terminal airspace controlled by the Comox military terminal control unit at 19 Wing Comox.[3] In this military terminal area, regulations require a minimum spacing between aircraft of 3 nm horizontally or 1000 feet vertically, but in the Nootka sector, 5 nm is required. A formal agreement between the Department of National Defence and NAV Canada further defines the responsibilities and the procedures applying to all aircraft transiting the two airspaces.[4] In part, the arrangement requires that aircraft be separated by at least 5 nm when entering Comox airspace. In this incident, the required spacing between the two aircraft was not met and was unintentionally reduced to 0.8 nm at the same altitude.

In the event of an increase in traffic volume and complexity, a controller in this complex has the option of splitting his or her sector to reduce the workload for that position. Such a split is commonplace and typically involves engaging a controller to open up another position to handle a specific area of responsibility. Splitting a sector is usually coordinated with the unit supervisor or the ACC shift manager, but if neither is available, a senior controller can initiate and coordinate such a split. In this incident, the involved radar controller assessed that the workload at the time did not warrant a sector split.

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[3] Canadian Department of National Defence (DND)

[4] Vancouver/Comox Control Arrangement—Schedule A to DND/NC Agreement (01 November 1998)

NAV Canada instructions stipulate that the radar and the data positions are both responsible for continuously scanning the flight data board for conflicts.[5] After the radar and data positions have coordinated, the radar controller is responsible for maintaining separation between radar-identified aircraft. The flight progress strips for all the aircraft had been correctly prepared and arranged on the flight data board in accordance with normal unit practices. The radar controller had set his radar information monitor to the usual radius range of 200 nm, and the aircraft targets and data blocks (tags) were correctly displayed. This 200-nm radius range ensures that the entire sector airspace was displayed. Because of the number of aircraft targets and tags, some of the data blocks intermittently overlapped each other.

Neither the data controller nor the radar controller placed a warning indication on the strips of C-GKOS or VAL712 to indicate the potential conflict, even though both aircraft would be flying at 17 000 feet. The radar controller's initial assessment, made when he cleared C-GKOS to 17 000 feet, was that the two aircraft would not conflict when their flight paths crossed. He did not use any of the display tools, such as predicted track line or range bearing line, to determine an accurate track crossing time for the two aircraft. No estimates were calculated for the point where the two aircraft crossed tracks.

Analysis

The chain of events that led to this loss of separation and ultimately to the risk of collision comprised deficiencies in controller planning, executing, and monitoring, and a breakdown of the radar controller's situational awareness (a mental picture of relevant traffic). It could be argued that the actual loss of separation was initiated when the radar controller cleared C-GKOS to 17 000 feet, since at that time he did not accurately assess the relative positions and the progress of the two flights toward each other.

When the data controller passed an estimate and an altitude for C-GKOS to Comox, the flight progress strips were not annotated to indicate a conflict, because there was no attempt to assess the relative positions of the two aircraft where the tracks would cross. The collision path geometry of the radar targets was evident on the radar controller's radar information display for at least 12 minutes before the potential collision was pointed out to him. However, he did not indicate the potential conflict between C-GKOS and VAL712 on the flight progress strip and continued to rely on his initial assessment that the two aircraft would not conflict at the time their flight paths crossed. The radar controller did not use any of the radar display tools to assist him in monitoring the progress of the two aircraft toward their flight paths' intersection point. Without the use of the available display tools, neither the information on flight progress strips nor on the radar display was compelling enough to alert the controllers to the potential conflict.

Once the radar controller recognized the quickly developing risk of collision (at about 1351:50), he sought to employ an altitude change to C-GKOS to avoid a collision. He did not warn each aircraft of the other, he did not ascertain if either aircraft had the other in sight, and he did not issue a flight path change to VAL712. His difficulties were made more complex by the short time available to assess the dynamic situation and execute an evasive plan after the Comox controller alerted him to the conflict. Initially, the radar controller did not know if the pilots in VAL712 had seen C-GKOS, thus compounding his aircraft management difficulties. It would have been prudent for the radar controller to have also issued evasive instructions to VAL712, whether

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[5] NAV Canada Operations Letter 01-02 for the West Complex (15 January 2001)

altitude change, directional change, or both. However, since he was required to display a large range to ensure the entire airspace for which he had responsibility, the radar targets of the two aircraft were likely so close that they were overlapping to some extent. This proximity or overlap would have made it difficult to quickly determine the exact lateral relationship between the two aircraft and to issue a suitable vector to resolve the conflict.

Had the radar controller used the correct call sign when he first issued the instruction to C-GKOS to descend and had the collision geometry remained constant, the descent instruction alone might have provided sufficient vertical spacing to avert a collision. The radar controller's evasion instruction issued to and acknowledged by C-GKOS was, however, ineffective because the altitude change occurred after the aircraft flight paths had crossed. However, the line of relative bearing had, by this time, begun to increase because C-GKOS had accelerated to cruising speed; hence, the risk of collision dissolved. The radar controller's improper aircraft identification nullified the chance of success for his plan of action, since this error added to the delay before the pilot received and actioned the altitude instruction.

Radar data show that C-GKOS began to descend about 20 seconds after the pilot received the clearance to maintain 15 000 feet; therefore, the pilot likely did not associate any degree of urgency to the altitude instruction. The pilot of C-GKOS likely became aware of the conflicting traffic through hearing the communications between the radar controller and VAL712 about the TCAS alert and the proposed descent to 15 000 feet. Had the radar controller used more imperative instructions to C-GKOS to descend (for example, by using the word "immediately") or pointed out the conflicting traffic, the pilot of C-GKOS would have been alerted to the developing situation and could have employed a more aggressive or earlier evasive descent. Either scenario would likely have established sufficient vertical spacing.

It was not determined why the radar controller did not consider VAL712 when issuing altitude clearances to C-GKOS. There were opportunities for him to be alerted to the conflict between VAL712 and C-GKOS: the flight progress strip for VAL712 indicated 17 000 feet and was laid out for the same direction of flight as C-GKOS, and radar information was correctly displayed. In the five minutes before issuing C-GKOS the clearance to 17 000 feet at 1341:24, the radar controller had significantly less activity, a situation that normally is not conducive to a loss of situational awareness. However, in the few minutes before the risk of collision, he was engaged in controlling two aircraft in and out of Port Hardy; he might have focused on these activities to the exclusion of monitoring C-GKOS and VAL712.

In essence, the radar controller lost situational awareness at about the time he cleared C-GKOS to 17 000 feet and caused a loss of separation between the two aircraft. He did not take any action to calculate crossing times or use any of the display tools available to him to update his original mental model of the relative positions and progress of the two aircraft. When later presented with a rapidly developing conflict, he issued instructions that were ineffective to reduce the risk of collision. The collision geometry was changed by C-GKOS's acceleration. The last defence mechanism available to prevent an in-flight collision and the only factor that safeguarded against a collision was the VAL712 pilots seeing C-GKOS and the subsequent TCAS alert.

Findings as to Causes and Contributing Factors

1. The radar controller lost situational awareness, issued an altitude clearance to C-GKOS that directly conflicted with VAL712, and, thus, initiated the loss of separation.

2. The radar controller and the data controller did not identify the developing traffic conflict until, at the handoff, the Comox controller apprised the radar controller of the conflict. As a result, the radar controller had little time to manoeuvre the aircraft effectively to reduce the risk of collision.

3. The radar controller twice used the wrong call sign for C-GKOS when he issued corrective instructions. As a result, the pilot received the descent instructions too late to reduce the risk of collision.

Findings as to Risk

1. Because the radar controller did not use imperative radio phraseology with the C-GKOS pilot, the timely response the controller had expected did not take place. Imperative phraseology would have indicated a degree of urgency to descend.

2. The radar controller and the data controller did not mark the flight progress strips to indicate the potential conflict, either when the estimate for C-GKOS was initially passed to Comox or when C-GKOS was cleared to maintain 17 000 feet. As a result, the likelihood of detecting the conflict during a later scan of the strips was reduced.

3. The radar controller relied on an initial cursory comparison of the flight paths of the two aircraft to determine whether a conflict existed. He did not update his situational awareness through more exacting means, such as estimating crossing times or using radar display tools.

Safety Action

On 14 February 2002, Vancouver ACC issued an operations bulletin to all controllers concerning *Air Traffic Control Manual of Operations* 507.1—Safety Alert, including the requirement for direct and imperative phraseology and exchange of traffic information. This issue is covered again during unit recurrent/refresher training.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 August 2002.

Appendix A—Chronology of Main Events

Chronology of Main Events (PDT)		
Time	**Unit**	**Event**
		VAL712 is cruising at 17 000 feet en route to Vancouver
1334:48		*C-GKOS departs Port Hardy*
1334:58	C-GKOS	Calls NK[6] passing 2000 feet
1335:09	NK	Clears C-GKOS to 15 000 feet
1337:22	PCO807	Calls NK at 16 000 feet, inbound to Port Hardy
1338:57		*Constant relative bearing established between C-GKOS and VAL712*
1341:24	NK	Clears C-GKOS to 17 000 feet
1341:49	NK	Clears VAL721 to 14 000 feet
1342:22	NK	Clears PCO807 to 12 000 feet
1345:20		*N199BB departs Port Hardy*
1345:37	NK	Clears PCO807 to Port Hardy airport at 12 000 feet
1347:18	N199BB	Calls NK passing 5000 for 11 000 feet
1348:00	NK	Radar identifies N199BB and advises of PCO807 at 12 000 feet
1349:14		*Spacing between C-GKOS and VAL712 is 7 nm and 1000 feet*
1349:17	NK	Clears N199BB to FL290
1349:42	NK	Clears PCO807 to 8000 feet
1350:07		*NAV Canada / DND agreed 5-nm spacing occurred between C-GKOS and VAL712*
1350:22		*Spacing between C-GKOS and VAL712 is 4.8 nm at 17 000 feet*
1350:30	NK	Clears PCO807 for an approach at Port Hardy
1350:44	NK	Hands off PCO807 to Port Hardy Flight Service Station
1351:10		*Spacing between C-GKOS and VAL712 is 3 nm at 17 000 feet*
1351:24	NK	Clears N199BB to FL330
1351:33	NK	Hands off C-GKOS at 17 000 feet to Comox Military Terminal Control Unit

[6] Nootka radar controller

1351:39		*Previous constant relative bearing between C-GKOS and VAL712 starts to increase (C-GKOS pulls ahead of VAL712)*
1351:42	Comox	Points out to NK VAL712 in proximity of C-GKOS
1351:50	NK	Recognizes conflict between VAL712 and C-GKOS
1352:05	NK	Instructs "GKS" to maintain 15 000 feet
1352:17	NK	Instructs "GKS" to maintain 15 000 feet
1352:21	NK	Instructs "KOS" to maintain 15 000 feet
1352:23	C-GKOS	Acknowledges 15 000 feet
1352:30		*C-GKOS's flight path crosses 0.85 nm ahead of VAL712's flight path*
1352:30	VAL712	Asks NK if he is aware of Cessna traffic ahead
1352:32		*Spacing between C-GKOS and VAL712 is 0.8 nm at 17 000 feet*
1352:37	NK	Advises VAL712 that Cessna is descending to 15 000 feet
1352:40	VAL712	Advises NK of the TCAS TA and that they are visual with C-GKOS
1352:46		*C-GKOS begins to descend from 17 000 feet*
1352:59	NK	Hands off C-GKOS to Comox