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1.0

FACTUAL INFORMATION

1.1

History of the Flight

On 26 June 1989, a Conifair Inc. Douglas DC-6A, registration C-GBYA, took off from Bonaventure Airport, Quebec for a spray operation 30 miles southeast of Sainte-Anne-des-Monts. The aircraft was to return to Bonaventure after the flight. This was to be the last spraying flight of the season out of the Bonaventure base. A crew of four was on board, including two flight engineers who were on a familiarization training flight. The aircraft was carrying 2,952 U.S. gallons of Dipel 132 insecticide. Dipel 132 is a non-toxic microbial insecticide.

The aircraft took off from Bonaventure at 1915 eastern daylight time (EDT)* and arrived over the spray area at 1935. The spotter aircraft, a Cessna 310, was waiting for the DC-6A over the spray area. Two blocks were to be sprayed. The supervisor in the spotter aircraft contacted the co-pilot of the DC-6A, and it was decided that block 218 would be sprayed first. The crew was using an inertial navigation system (INS)** to follow pre-established spraying tracks within each block.

The first track was sprayed uneventfully. At the end of the first track, the aircraft made a 180-degree turn to spray the second track, which was parallel to and about 800 feet northeast of the first track. This meant that the aircraft had to fly from a valley at an elevation of 1,000 feet above sea level (asl) up a mountain consisting of two levels. The first level is about 1,800 feet asl and about 3,280 feet along the flight path. After the first level, the terrain rose within approximately 1,000 feet along the flight path, to the summit of the mountain at an elevation of 2,175 feet asl (see Appendix A).

The pilot in the spotter aircraft, and the co-pilot of the DC-6A were communicating on the radio during the spray operations.

The two occupants of the spotter aircraft observed a decrease of the DC-6A ground speed during the climb over the first level of the mountain.

* All times are EDT (Coordinated Universal Time (UTC) minus four hours), unless otherwise stated.

** See Glossary for all abbreviations and acronyms.

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They then noticed that the aircraft yawed and started a steep, left turn. The spotter crew stated that, shortly after the start of the left turn, the DC-6A left wing began to strike trees. The aircraft nosed down, crashed on the side of the mountain, and exploded. The four occupants were fatally injured in the accident.

The accident occurred at 1940 EDT, during the hours of daylight, at lat 48°38'30" N***, long 66°02'30" W, at an elevation of 2,050 feet asl.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	4	-	-	4
Serious	-	-	-	-
Minor/None	-	-	-	-
Total	4	-	-	4

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

Other damage was confined to the trees and soil at the accident site.

1.5 Personnel Information

	Pilot-in-Command	Co-Pilot
Age	33	32
Pilot Licence	Airline Transport	Senior Commercial
Medical Expiry Date	01 September 1989	01 February 1990
Total Flying Time	7,586 hr	8,022 hr
Total on Type	940 hr	49 hr
Total Last 90 Days	70 hr	184 hr
Total on Type		
Last 90 Days	70 hr	49 hr
Hours on Duty		
Prior to Accident	1 hr	1 hr
Hours off Duty Prior		
to Work Period	11 hr	11 hr

*** Units are consistent with official manuals, documents, reports and instructions used by or issued to the crew.

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The crew was certified and qualified for the flight in accordance with existing regulations. Neither pilot had participated in Cockpit Resource Management (CRM) or Pilot Decision Making (PDM) courses, nor was it required by regulations. They had been flying as a crew for a period of about seven weeks.

1.5.1 Pilot-in-Command

The captain of the aircraft was the company chief pilot, and had over 940 flying hours on type. He was described as an individual who was very sure of himself and sometimes daring in the way he flew the DC-6A.

The captain began working for Conifair Aviation in May 1984 as a co-pilot on the Lockheed L-749 Constellation. He was promoted to captain on the DC-4 and DC-6A in July 1988. In March 1989, he was authorized by Transport Canada as a check pilot on Douglas DC-4 and DC-6 aircraft and was appointed company chief pilot. His last recurrent training on the DC-6 was in May 1989. He occupied the left seat on this flight.

About three weeks previously, the spotter supervisor, who has 10 years operational experience, had observed this crew flying very low while spraying over hilly terrain. He felt that this practice was dangerous and made a comment to that effect to the captain, reminding him that it was not necessary to fly at such a low altitude while spraying, especially over mountainous terrain. The captain did not respond to this comment, and the crew continued flying at the same low altitude. The spotter supervisor did not report this conversation with the DC-6A captain until after the accident.

1.5.2 Co-Pilot

The co-pilot was employed by Conifair Aviation since June 1986. He started with the company as a co-pilot on the DC-4; then he was promoted to the DC-6. He had completed his initial training on the DC-6 in May 1989 and was qualified on type. He occupied the right seat during this flight. The co-pilot was described as a very enthusiastic individual. He was relatively inexperienced on type, having accumulated only 49 hours on the DC-6A.

1.5.3 Flight Engineers

The presence of a flight engineer on board the aircraft is not necessary during spraying operations. The chief pilot had just recruited the two flight engineers and was training and familiarizing them with the aircraft systems. One trainee occupied the flight engineer's

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seat. The other was seated behind the tanks in the cabin and was ensuring that the spray pumps were operating normally.

1.6 Aircraft Information

Manufacturer	Douglas Aircraft Company
Type	DC-6A
Year of Manufacture	1953
Serial Number	43717
Certificate of Airworthiness	Restricted Valid
Total Airframe Time	24,220 hr
Engine Type (4)	Pratt and Whitney Double Wasp R2800-CB16
Propeller Type (4)	Hamilton Standard 43E60-573
Maximum Allowable Take-off Weight	103,800 lb
Recommended Fuel Type	100/130 avgas
Fuel Type Used	100/130 avgas

The aircraft weight was approximately 93,680 pounds at the time of the accident. The aircraft had a restricted category airworthiness certificate for spraying operations issued pursuant to a Flight Manual supplement published and approved by Transport Canada. For the take-off distance and climb, the performance section of the manual supplement refers the reader to the Federal Aviation Administration (FAA) Approved Flight Manual for the normally configured C-118 Series/DC-6 aircraft.

The aircraft was configured in such a manner that there was only one INS track indicator on board. It was mounted on the captain's instrument panel at eye level for the pilot-in-command to navigate and follow terrain contours without a great deal of eye movement. Pilots-in-command with experience in spraying operations indicated that they would let their co-pilot fly to and from the spray area only if he was experienced. However, because of the INS track indicator location, co-pilots seldom flew during the actual spraying.

The aircraft weight and centre of gravity of the DC-6A were within prescribed limits. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.

The DC-6A has a wing span of 117 feet.

It was company procedure to use climb power for spraying operations.

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The crew of the spotter aircraft reported that the quick-load-jettison system of the DC-6 was not operated during the flight, and that nothing abnormal was observed until a few seconds prior to impact.

1.7 Meteorological Information

1.7.1 Weather Conditions

Environment Canada reported visual meteorological conditions (VMC) at the time of the accident. Southern Quebec was between two weak depressions, one located west of the Abitibi region, the other to the north of Anticosti Island. The weather analysis indicates that a cold front was moving through Gaspésie, carrying slightly dryer air. Surface winds were light and variable, and the 850 millibar chart indicates light winds at upper levels. The network of weather stations reported no turbulence or significant winds for the Gaspésie area.

No turbulence or clouds were reported in the area. The Cap-Chat automatic weather station, located about 40 miles from the accident site, reported a temperature of 19 degrees Celsius and a dew point of 13 degrees Celsius.

1.7.2 Spotter Crew Observations

The two occupants of the spotter aircraft said that weather conditions were favourable for visual flight. The wind was calm, and the visibility was over 15 miles.

1.8 Aids to Navigation

No ground navigation aids were used. The aircraft was equipped with an INS to guide the crew along pre-determined spray tracks.

1.9 Communications

Communications between the two aircraft were normal. Radio messages from the DC-6A did not indicate that the crew had any problems with their aircraft prior to the accident.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder (FDR) or cockpit voice recorder (CVR), nor was either required by regulation.

1.12 Wreckage and Impact Information

1.12.1 General

The aircraft struck rising terrain near the top of the tree-covered mountain at an elevation of approximately 2,050 feet asl. It had cleared the first level of the mountain and initiated a left turn. The first tree strike was made by the left wing at about 2,050 feet asl, and subsequent tree strikes led to a wreckage trail approximately 1,000 feet long and 200 feet wide, oriented on a heading of 120 degrees magnetic (M). The mean slope of the terrain at the site is 30 degrees.

1.12.2 Breakup Sequence

The left wing tip of the aircraft struck trees on a heading of 120 degrees M. The aircraft immediately began to descend into the trees, and the number of tree strikes increased. The shape of the swath in the trees is consistent with a constant 45-degree left bank attitude. The left wing disintegrated, and the fuel spilled forward and ignited, producing a huge fire-ball. The aircraft pivoted left and nosed down. The cockpit separated from the fuselage when it struck the ground. The remainder of the cabin separated, pivoted 180 degrees, slid on its back, and came to rest on a heading of 300 degrees M.

A severe fuel-fed fire ensued. Most of the aircraft's aluminum parts were burned or melted. Only the steel parts withstood the intense heat of the fire.

1.12.3 Wreckage Examination

The engines were examined at the site. It was determined that all four were operating normally prior to impact. It was estimated that the engine power was between climb and take-off level. Other components (propellers, some flight instruments) were shipped to the TSB Engineering Laboratory for detailed examination and analysis. Both altimeters indicated the same altitude and showed the altimeter setting for Bonaventure, from where the aircraft took off.

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There was no evidence of any systems malfunction or pre-impact failure of any flight control surfaces of the aircraft.

It was also determined that the landing gear and flaps were in the UP position at impact, and that the quick-load-jettison system had not been activated.

1.13 Medical Information

The crew had 11 hours off before reporting for duty. They had flown together several times over the last six weeks. There was no evidence that incapacitation, physiological or psychological factors affected the crew's performance. Toxicological analysis was carried out by the Civil Aviation Medical Unit. There was no evidence of drugs, carbon monoxide or alcohol. Both crew members were found in their respective seats. The autopsy report could not determine who was flying the aircraft at impact.

1.14 Fire

A severe fuel-fed fire broke out after the crash, destroying a large portion of the aircraft. As a result, some components could not be found, and an examination of the entire aircraft could not be made. The fire was most intense in the wings and aft section of the fuselage; there was no fire in the other areas of the aircraft. The tanks contained about 9,739 pounds of fuel at impact.

The spotter supervisor reported the crash immediately, and a forest fire crew was dispatched to the site. They brought the fire under control the next morning. Access to the crash site was difficult because it was a considerable distance from the nearest road.

1.15 Survival Aspects

The accident was not survivable because of the large deceleration forces and the intensity of the fuel-fed fire.

A Search and Rescue (SAR) helicopter was dispatched; it arrived before nightfall, overflew the area, and determined that there were no survivors.

The emergency locator transmitter (ELT) did not activate. It was not found, and it is presumed that it

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was destroyed in the post-crash fire. No signals were received by the Search and Rescue Satellite (SARSAT).

1.16 Tests and Research

1.16.1 Instrument Analysis

The laboratory analysis established that the airspeed indicator was reading approximately 130 knots at ground impact; that the numbers one and three engine tachometer needles indicated at least 1,500 rpm at impact; that the needle of the number one engine fuel-flow indicator showed a rate of at least 250 U.S. gallons per hour (gph) at impact; and that the number three engine fuel flow indicator needle was in the 245 to 250 U.S. gph range. For the aircraft weight and speed, normal climb-power fuel flow at low altitude would have been approximately 250 gph.

1.16.2 Propeller Analysis

Analysis of the propellers revealed that all four propellers were turning at high speed at impact.

1.16.3 Manufacturer's Analysis of Aircraft Performance

It was essential to determine whether the aircraft in this configuration could clear the mountain with climb or full power applied.

McDonnell Douglas Company was asked to perform an aircraft performance analysis. Company representatives said at the outset that the aircraft was not designed for insecticide spraying, but for transporting passengers and cargo at high altitude. It was, therefore, very difficult for them to obtain air data for the aircraft in this configuration. Consequently, even though the spraying apparatus mounted over the wings decreased the climb performance of the aircraft, because the lack of data, the resulting penalties were not taken into account in the performance calculation analysis.

Because the height of the aircraft above the first level of the mountain slope could not be confirmed, performance was calculated based on three different aircraft altitudes at the start of the climb: 50 feet above ground level (agl), 75 feet agl and 100 feet agl.

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The analysis carried out by the performance engineers revealed that, at climb power, which was the setting usually used during spraying operations, the aircraft could not have cleared the summit of the mountain from any of the three altitudes mentioned above.

Disregarding the performance penalties of the spray apparatus mounted over the wings, it was also calculated that the aircraft could have cleared the summit of the mountain only if maximum take-off power had been applied throughout the climb, the climb had been initiated at least 3,170 feet horizontal distance from the hill, and if the aircraft had been above 75-foot agl at the start of the climb.

1.16.4 Water-Methanol Injection System

The DC-6A uses a water-methanol injection system to increase engine horsepower when extra performance is needed. It was determined that the water-methanol injectors had not been used during the flight.

1.17 Additional Information

The "Manuel de surveillance aérienne", published by the Aerial Spraying Techniques Division of the Energy and Resources Department of Quebec, indicates that the pilot is not required to follow the lowest terrain contours while spraying in mountainous regions. The manual recommends flying 150 to 300 feet above the summit of the mountains and hills.

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2.0

ANALYSIS

2.1

Introduction

The analysis focused on aircraft performance and crew performance. The investigation was difficult because the aircraft was not equipped with an FDR or a CVR.

2.2

Aircraft Performance Analysis

There was no evidence of airframe failure or system malfunction before or during the flight.

The manufacturer initially designed the DC-6A for transporting passengers and cargo. The performance of the aircraft is particularly suited to high-altitude cruise rather than low-altitude flight as required for insecticide spraying operations.

The approved performance section of DC-6A Flight Manual states that crew members are to use information provided in the manual for the normally configured C-118 Series/DC-6 aircraft when calculating take-off and climb distances. This DC-6A had been modified with pipes over the wings for spraying operations. The aircraft had never been flight tested to evaluate the performance degradation caused by this unorthodox configuration. Therefore, the crew members were using suspect data when calculating take-off and climb performance.

It was reported by other DC-6A crew members that climb power was normally used when spraying. Engineering and laboratory examination established that all four engines were operating and producing power at impact. The exact power level could not be determined, but it was estimated to be between climb and take-off level. It was also estimated, by laboratory examination of the airspeed indicators, that the speed at which the aircraft struck the mountain was approximately 130 knots.

The analysis carried out by performance engineers revealed that a normally configured DC-6A, at climb power, which was the normal setting used during spraying, could not have cleared the mountain top from 50, 75 or 100 feet agl at the start of the climb. The performance penalties associated with the spray apparatus above the wings of this DC-6A would have further degraded its performance.

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The same analysis also concluded that, disregarding the penalties associated with the spray modification, the DC-6A could have cleared the mountain top only if maximum take-off power had been applied throughout the climb and if the aircraft had initially started the climb at an altitude above 75 feet agl.

Experienced eyewitnesses reported that the left wing touched the trees shortly after the aircraft started a left turn. The DC-6A wing span is 117 feet, and each wing is about 50 feet long. Since the left wing touched some trees during the turn, it indicates that the aircraft was probably flying under 75 feet above the trees when the turn was started.

There were no indications that the quick-load-jettison system was activated prior to impact.

The 1,000 foot length of the wreckage trail up the mountain indicates high forward speed and lends itself to the conclusion that the DC-6A was not stalled prior to initial impact.

Because the left slope of the mountain ahead was lower, the pilot at the controls probably decided to turn left in order to try to avoid hitting the rapidly rising terrain ahead of him. When the aircraft was banked left, the left wing of the aircraft struck the trees, causing it to crash.

2.3

Flight Crew Performance

Experienced eyewitnesses indicated that this crew routinely flew very low and had been seen contour flying over mountainous terrain. The crew did not comply with the safety instructions set out in the spraying operations manual issued by the Energy and Resources Department of Quebec even after being reminded about flying low over mountainous terrain. The manual directs that aircraft maintain 150 to 300 feet above the summit of mountains and hills when spraying in mountainous regions. By flying below these recommended altitudes, even after being questioned, the crew reduced their margin of safety.

The very experienced captain was confident of his abilities and had routinely flown the aircraft very low in the past. His co-pilot was relatively inexperienced and, consequently, would be unlikely to challenge the captain's techniques or decisions. None of the crew members had had the benefit of CRM or PDM training.

3.0

CONCLUSIONS

3.1

Findings

1. The aircraft was not equipped with a FDR or a CVR, nor was either required by regulation.
2. The company was using the Transport Canada approved Flight Manual for the standard configuration DC-6 aircraft when calculating take-off distance and climb performances.
3. Flight tests have never been performed on the DC-6A aircraft configured with the installation of spraying equipment on top of the wings.
4. There was no evidence of airframe failure or system malfunction before or during the flight.
5. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.
6. The aircraft weight and centre of gravity were within the prescribed limits.
7. The aircraft quick-load-jettison system was not activated.
8. The crew was certified and qualified for the flight in accordance with existing regulations.
9. The crew was flying at low altitude, following the terrain contours, and reduced the required margin of safety for spraying operations in mountainous regions.
10. The crew, flying the aircraft at low level, initiated a spraying run up a mountain which exceeded the climb performance of the aircraft.
11. The pilot at the control of the aircraft probably initiated a left turn when he realized that the aircraft could not clear the second mountain top straight ahead. The left wing struck the trees in the turn, and the aircraft subsequently crashed.

3.2

Causes

On a low-level spraying flight, the crew attempted a climb over rising terrain which exceeded the climb performance of the aircraft.

4.0

SAFETY ACTION

4.1 **Action Taken**

4.1.1 **Minimum Altitudes for Spraying Operations**

Following this investigation, the Quebec Department of Energy and Resources, in cooperation with Conifair Aviation Inc., issued revised safety measures for DC-6A and DC-4 aircraft on spraying operations. The minimum flight altitude in the spraying operations manual issued by the Department was changed from the range of 100 to 300 feet to the range of 75 to 100 metres (246 to 321 feet) above the summits of hills.

4.1.2 **Take-off and Climb Performance Charts**

During the investigation of this accident, it appeared that the Supplemental Type Certificate (STC) regarding the installation of the spray equipment did not take into consideration the possible degradation of performance as a result of the installation. Therefore, an Aviation Safety Advisory was forwarded to Transport Canada suggesting that Transport Canada review the guidance provided in the Approved Flight Manual Supplement for DC-6A aircraft to ensure that any take-off and climb performance degradation caused by the additional drag associated with the spraying apparatus was considered adequately.

4.2 **Action Required**

The Board will consider the requirement for safety action after it reviews comments from parties of direct interest.