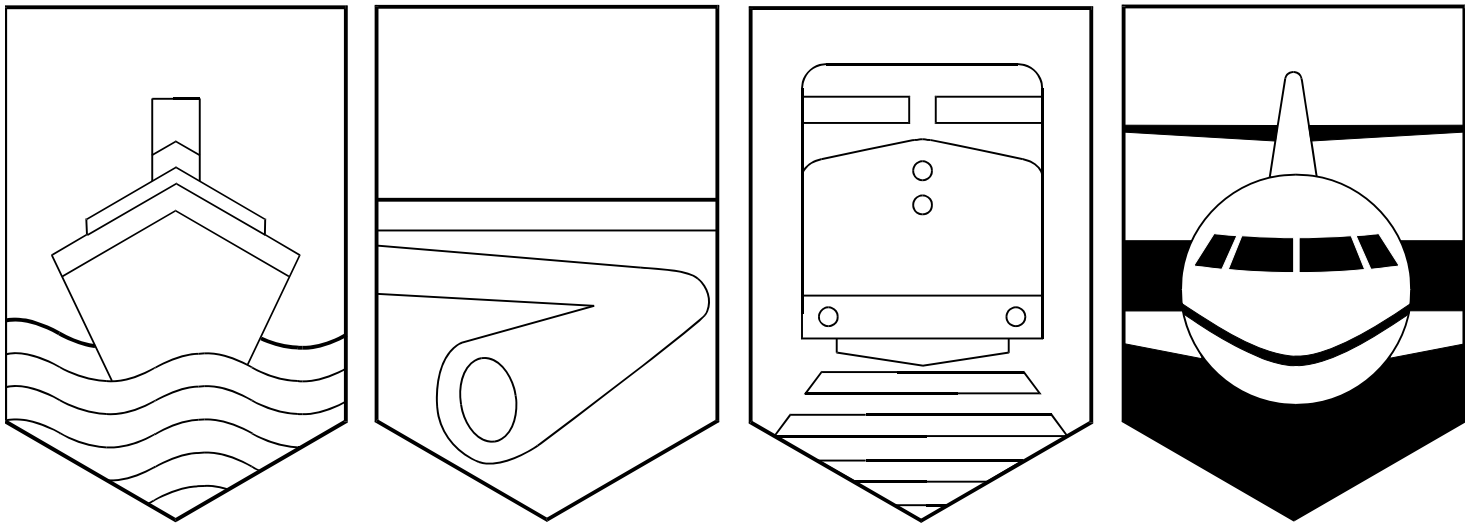
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



AVIATION OCCURRENCE REPORT

COLLISION WITH TERRAIN

CESSNA 188 AGWAGON C-GYUD
MARENGO, SASKATCHEWAN 2 mi S
29 JUNE 1994

REPORT NUMBER A94C0119

Canada

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

INDEPENDENCE

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.

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Aviation Occurrence Report

Collision with Terrain

Cessna 188 Agwagon C-GYUD
Marengo, Saskatchewan 2 mi S
29 June 1994

Report Number A94C0119

Synopsis

The pilot of the Cessna 188 Agwagon was en route to a private airstrip after completing an aerial application of herbicide on a cereal crop south of Marengo, Saskatchewan. When the aircraft did not arrive at the airstrip, a search was conducted, and the wreckage was located in a field near Marengo. The pilot had sustained fatal injuries and the aircraft was destroyed.

The exact cause of the accident could not be determined. While en route to his destination, the pilot most likely became incapacitated to such a degree that he allowed the aircraft to enter a descending turn and strike the ground. The pilot's incapacitation may have been caused by an inner ear disorder. Possible contributing factors were fatigue, resulting from the pilot's work schedule, and the effects of agricultural chemicals.

Ce rapport est également disponible en français.

Table of Contents

1.0 Factual Information

1.1 History of the Flight

The pilot of the privately registered Cessna 188 aircraft was returning to his base at a private airstrip two miles south of Marengo, Saskatchewan, from a herbicide application flight. The flight was conducted in accordance with visual flight rules (VFR)[1]. When the aircraft failed to return to the airstrip, a search was conducted, and the wreckage was located in a field about one mile southwest of the airstrip. The pilot, the sole occupant, had sustained fatal injuries.

The accident occurred about 0930 central standard time (CST)[2], during daylight hours, at latitude 51°27'N and longitude 109°47'W.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	1	-	-	1
Serious	-	-	-	-
Minor/None	-	-	-	-
Total	1	-	-	1

1 See Glossary for all abbreviations and acronyms.

2 All times are central standard time (Coordinated Universal Time (UTC) minus 6 hours) unless otherwise stated.

1.3 Damage to Aircraft

The aircraft was destroyed by the impact forces.

1.4 Other Damage

There was some damage to a cereal crop in the field where the wreckage was located.

1.5 Personnel Information

	Pilot
Age	24
Pilot Licence	CPL
Medical Expiry Date	01 FEB 1995
Total Flying Time	578 hr
Total on Type	220 hr
Total Last 90 Days	123 hr
Total on Type Last 90 Days	123 hr
Hours on Duty Prior to Occurrence	5 hr
Hours off Duty Prior to Work Period	7 hr

The pilot was certified and qualified for the flight in accordance with existing regulations.

1.6 Aircraft Information

Manufacturer	Cessna Aircraft Company
Type	188 Agwagon
Year of Manufacture	1967
Serial Number	188-0302
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	2,860 hr
Engine Type (number of)	Continental O-470-R (1)
Propeller/Rotor Type (number of)	McCauley 2A34C66N constant speed (1)
Maximum Allowable Take-off Weight	3,800 lb
Recommended Fuel Type(s)	80/87 or 100/130 aviation gasoline
Fuel Type Used	Farm grade automotive gasoline

The aircraft was a single-place, low-wing, conventional-gear monoplane. It was equipped with a hopper, mounted in the fuselage forward of the cockpit, and wing-

mounted spray booms for agricultural chemical application. The aircraft was not equipped with a breathing air filtration system for the pilot. Not all agricultural application aircraft are equipped with such a system, nor is it required by regulation. The Pilot's Operating Handbook for the aircraft lists its normal cruising speed at 2,500 feet above sea level (asl) as between 103 and 125 miles per hour (mph)[3] depending on power setting and configuration.

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

The aircraft's aileron control cables were past due for replacement based on "time in service." New cables were on order at the time of the accident, and arrangements had been made for the cables to be replaced. The aircraft's technical records indicate that, except for the control cables, the aircraft was certified and maintained in accordance with existing regulations. The aircraft's weight and centre of gravity were within prescribed limits at the time of the accident.

1.7 Meteorological Information

The area forecast predicted scattered cloud based at 10,000 feet asl, with variable broken cloud based at 12,000 feet asl.

The 0900 weather observation at Kindersley, Saskatchewan, about 30 nautical miles (nm) east of the accident site, was thin scattered cloud based at 1,500 feet above ground level (agl), another thin scattered layer of cloud based at 4,000 feet agl, visibility 15 miles, temperature 15 degrees Celsius, and winds from the east at 8 knots.

Witnesses describe the weather on the morning of the accident as generally clear, with light winds.

1.8 Flight Recorders

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

1.9 Wreckage and Impact Information

The aircraft struck the ground on a southwesterly heading in a 40-degree nose-down and 15-degree right-wing-low attitude, at a speed in the normal cruising range. Some of the aircraft instruments were recovered and submitted to the TSB Engineering Branch Laboratory. The engine instruments indicated that the engine was producing normal cruise power at the time of impact. Examination of the vertical speed indicator revealed that it was indicating 3,000 feet per minute (fpm) down at the time of impact (Engineering Branch Report LP 110/94).

The left wing flap cables failed at the pulley inside the fuselage and the left aileron cable failed in the vicinity of the aileron cable swage ball fitting. The failed aileron and flap cables were also submitted for examination to the TSB Engineering Branch Laboratory. The cable failures were determined to be the result of loading in excess of the cables' specified breaking strength and most probably occurred during the crash impact (Engineering Branch Report LP 109/94).

The engine and propeller were taken to the TSB Regional wreckage examination facility. Propeller damage was consistent with power being produced at the time of impact. Examination of the

4 See diagram of the area and the aircraft's last observed flight path in Appendix A.

engine did not reveal any pre-existing defects. Internal damage in the engine indicated that it was producing power at the time of impact with the ground.

The aircraft was extensively damaged by the force of the impact with the ground. The aircraft systems were examined to the degree possible, and no evidence of a malfunction was found.

1.10 Flight Path

The aircraft had been observed in straight and level flight at an altitude of about 500 feet agl approximately two miles southwest of the crash site. At that time, the aircraft was headed in a northeasterly direction; nothing unusual was noted about the aircraft or its flight characteristics. The wreckage of the aircraft was located in a field of cereal grain about one mile from the aircraft's destination, in gently rolling cultivated terrain.[4] There were no power lines or other obstructions nearby.

The aircraft's flight path was reconstructed, based on its last observed position and on the position and orientation of the wreckage. The flight path required for the aircraft to arrive at the crash site from its last observed position is a descending turn with a diameter of one-half statute mile, commencing about one mile northeast of its last observed position. At the aircraft's normal cruise speed, the average bank angle required for the turn would be about
30 degrees, and the acceleration in the turn would be about 1.2 times the force of gravity (g). This bank angle and

acceleration was easily attainable by the accident aircraft.

1.11 Survival Aspects

The deceleration forces at impact exceeded the limit of human tolerance. Three of the four supporting structures of the pilot's seat failed in overload. The fourth (left rear) seat leg remained unbroken, but detached from its seat rail. The pilot was wearing an approved flight helmet at the time of the accident.

The aircraft was equipped with a combination lap belt and shoulder harness assembly. The Technical Service Order (TSO) label for the restraint system indicated that it was manufactured in 1966. The shoulder harness attachment, located behind and above the pilot's head, was a solid attachment on the primary cockpit structure, and was found intact. The stitching for the two shoulder harness straps failed at the lap belt attachment, and the shoulder harness stitching at the left attachment hardware failed as well.

The failure of the harness occurred in the stitching between the fabric layers. Since there is no specified "life limit" for the restraint system, replacement is "on condition." A 50-hour inspection of the aircraft was carried out 19 days before the accident. One of the items to be checked on the 50-hour inspection is the seat-belt and shoulder harness. Inspection of these items is done by visual inspection. Any progressive weakening of the stitching would probably not be visible on external inspection of the harness.

1.12 Medical Information

The autopsy indicated that the pilot sustained multiple non-survivable injuries. Toxicology testing was conducted at the Civil Aviation Medical Unit (CAMU) at the Department of National Health and Welfare in Toronto, Ontario, and at the RCMP Forensic Laboratory in Regina, Saskatchewan.

Test results for the presence of common drugs were negative. The pilot was reportedly applying 2,4-D Ester, Buctril M, and Laser agricultural herbicides on the day of the accident. Test results for the presence of the active ingredients in these herbicides were negative. Test results for the presence of the solvents, in which the active ingredients were dissolved, were also negative; however, these

solvents are volatile and they may have dissipated before the tests were carried out.

According to the information in the material safety data sheets (MSDS) provided by the manufacturers, symptoms of exposure to these herbicides include dizziness, shortness of breath, nausea, muscle spasms, and eye irritation.

1.13 Inner Ear Disorder

During the evening of Sunday, June 26, three days before the occurrence, the pilot experienced a period of vertigo (an illusion of movement or disorientation). At the onset of the disorder, the pilot indicated that he felt dizzy, and lay down in bed. He avoided discussing the matter and sought only to lie still. After the period of dizziness ended, the pilot reportedly felt somewhat groggy and tired. The pilot did not consult a doctor about the condition.

According to medical authorities, most non-transitory cases of vertigo result from disorders of the structures of the inner ear. Labyrinthitis, the most common such inner ear disorder, is usually caused by a viral infection. Persons suffering from labyrinthitis may experience periods of vertigo of such severity that they are incapacitated. Typical outward indications of vertigo include the patient's desire to lie down and avoid movement, in an attempt to keep from aggravating the situation. The most acute stage of the disorder usually lasts for several days; a complete recovery may take from four to six weeks. Persons suffering from the condition may or may not experience other symptoms of viral infection.

1.14 Organizational and Management Information

The pilot was the registered owner of the accident aircraft and the owner of the agricultural application company which operated the aircraft. The aircraft's permanent base was Stettler, Alberta, but the aircraft was operated during part of the application season from several private airstrips in the Marengo, Saskatchewan, area.

The pilot was the only full-time employee of the company; other people were engaged from time to time to assist in its operation. Most of the chemical applied by the pilot was supplied by the farmer who owned the field being treated. On the morning of the accident, an assistant helped mix the agricultural chemical, load the chemical into the aircraft, and mark the field where the chemical was being applied.

In addition to aerial chemical application, the pilot performed a number of other duties in the operation of his business. These duties included:

a. receiving orders for spraying and checking fields for obstructions and sensitive surrounding crops;

b. arranging for the purchase of some chemicals and arranging their mixing for application;

c. arranging for refuelling, and maintenance and repair of the aircraft;

d. maintaining a chemical log, and business records required for his business.

The pilot carried out these duties between flights, or on those days when weather or other factors precluded flight.

1.15 Pilot's Work Schedule

The pilot began the 1994 aerial application season in late April. From June 7 until June 29 (the day of the accident), he flew every day except June 11, 14, and 15. He departed on the first flight on the morning of the accident at about 0500. The pilot's flight times for the period before the accident, reconstructed from billing records and the aircraft log-book, indicate that he flew 26 hours in the last 7 days, 63 hours in the last 14 days, and 90 hours in the last 30 days.

The pilot went to sleep at 2330 the night before the accident, and awoke at 0430. He had maintained a similar schedule for several days before the accident, although his practice was to sleep during the day if he was working early in the morning and late in the evening. He was described as being tired on the morning of the accident. The application flights were conducted in the early morning and in the late evening. The pilot would typically work past sunset, approximately 2100.

1.16 Fatigue

Because of the subjective nature of fatigue, it is usually most difficult to determine with any certainty whether a particular person was at any time in a state of fatigue. Each individual varies in his or her ability to maintain mental stability and control under conditions which are generally regarded as conducive to fatigue, such as inadequate sleep or rest, poor health, excessive working hours, business pressures, etc. Some or all of these factors, often linked to a person's general health and the nature of his or her work, may lead to a state of fatigue which could adversely affect that person's motivation, concentration, and ability to exercise sound judgement in making decisions.

Transport Canada regulations limit daily "on duty" time to 15 hours. The same regulations also limit flying times to 120 hours for any 30-day period, and provide that a pilot should be scheduled for one day off duty in every seven days.

1.17 Safety Precautions

Application of agricultural chemicals must be conducted when winds are light to avoid having spray drift onto adjoining crops or residential areas. Winds are generally light during the early morning and late evening. Application flights are conducted at low altitude, and require frequent turns and numerous take-offs and landings.

The manufacturers of the agricultural chemicals applied by the pilot on the day of the accident recommend (in their MSDS) that persons using the products avoid physical contact with them, and wear approved respirators. The pilot was not wearing a respirator at the time of the accident, nor was it his practice to wear one when applying herbicides such as the ones used on the day of the accident. Witnesses reported that the pilot wore a respirator when applying pesticides or fungicides.

Witnesses reported that the general practice of agricultural application pilots is to wear respirators only when applying pesticide or fungicide.

Witnesses described the pilot's flying style as cautious and safety-conscious and reported that the pilot maintained his aircraft conscientiously, made relatively wide turns while spraying, and avoided aerobatic manoeuvres.

2.0 Analysis

2.1 Flight Path

A reconstruction of the aircraft's flight path shows that a descending 30-degree banked turn with an average acceleration of 1.2 g would be required to follow the calculated flight path. Since this flight path was well within the performance capabilities of the aircraft and is consistent with the aircraft wreckage, it is the most likely accident scenario. The aircraft was observed in normal flight shortly before the accident, no defects were found with the aircraft's engine and flight controls, and the weather was not a factor. It is likely, therefore, that the pilot lost situational awareness and allowed the aircraft to descend to the ground as a result of some degree of incapacitation.

2.2 Medical Factors

The symptoms experienced by the pilot on 26 June 1994, three days before the accident, are consistent with those of an inner ear disorder. The pilot may have suffered from this disorder without other indications of illness, because the disorder can be present without other outward indications. Because recovery from the disorder may take from four to six weeks, the vertigo that occurred on 26 June may have recurred at the time of the accident, although this cannot be proven. If a period of vertigo similar to the one of 26 June occurred in flight, the pilot could have become incapacitated as a result.

Although tests did not reveal the presence of agricultural chemicals or solvents, their presence cannot be ruled out because agricultural chemical solvents are volatile. If such solvents were present, they may have adversely affected the pilot's performance. The pilot's precautions against contact or ingestion of the agricultural chemicals being used were consistent with those observed by other pilots in the industry. However, the pilot's precautions were not as extensive as those recommended by the chemical manufacturers.

2.3 Fatigue

The pilot's flying schedule shows that, although he began the 1994 application season in late April, the busiest part of the season started in June. Because agricultural application requires low winds to limit drifting of the spray, most flights took place early in the morning or in the evening.

In addition to his flying duties, the pilot had the responsibility of operating his business. The time spent planning and carrying out business-related duties increased the pilot's workload and reduced the amount of time available during the day for sleep.

Although the pilot did not exceed the 30-day maximum flying time, he sometimes exceeded the 15-hour daily "on duty" time. Because the pilot sometimes napped during the day, he experienced a disturbance in his sleep patterns. Though it cannot be proven, it is possible that fatigue contributed to the pilot's loss of situational awareness.

2.4 Survival Aspects

The impact with the ground was not survivable because of the high deceleration forces. In an impact at lower speed, however, the failure of the pilot's shoulder harness would have been a factor affecting the chances of survival. The harness is checked at regular maintenance intervals by visual inspection, but, because the harness stitching between fabric layers is not visible, a visual inspection of the harness at maintenance intervals would probably not reveal any weakening of such stitching.

3.0 Conclusions

3.1 Findings

1. The pilot was certified and qualified for the flight in accordance with existing regulations.

2. The aircraft's technical records indicate that, except for the control cables, the aircraft was certified and maintained in accordance with existing regulations.

3. The engine was producing power at the time of impact with the ground.

4. No evidence of a failure or malfunction in any of the aircraft's systems was found.

5. The aircraft struck the ground in a descending turn at a speed in the normal cruise speed range.

6. The pilot experienced symptoms of dizziness and vertigo three days before the accident. The cause of these symptoms could not be determined; however, they were most likely the result of an inner ear disorder.

7. The pilot's flying and non-flying duties resulted in long hours of work. As a result, he may have been suffering from fatigue.

8. Toxicological testing did not reveal the presence of agricultural chemicals or solvents; however, because of the volatility of the solvents, their presence cannot be ruled out.

3.2 Causes

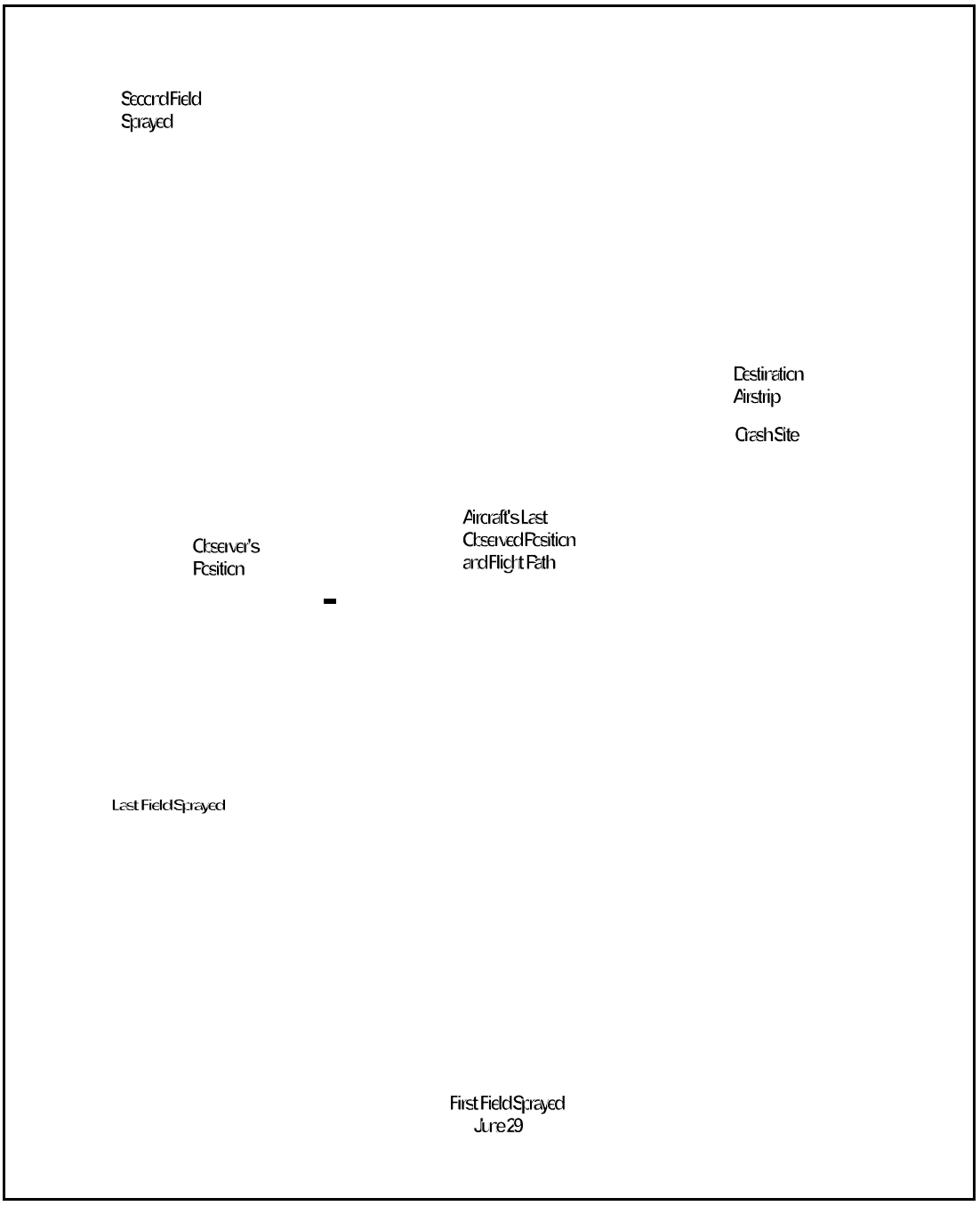
The exact cause of the accident could not be determined. While en route to his destination, the pilot most likely became incapacitated to such a degree that he allowed the aircraft to enter a descending turn and strike the ground. The pilot's incapacitation may have been caused by an inner ear disorder. Possible contributing factors were fatigue resulting from the pilot's work schedule, and the effects of agricultural chemicals.

4.0 Safety Action

The Board has no aviation safety recommendations to issue at this time.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Hugh MacNeil, authorized the release of this report on 21 April 1995.

Appendix A - Map of Area Showing Last Observed Flight Path



Appendix B - List of Supporting Reports

The following TSB Engineering Branch Laboratory Reports were completed:

LP 109/94 - Cables Examination; and

LP 110/94 - Instrument Analysis.

These reports are available upon request from the Transportation Safety Board of Canada.

Appendix C - Glossary

agl	above ground level
asl	above sea level
CAMU	Civil Aviation Medical Unit
CPL	Commercial Pilot Licence
CST	central standard time
fpm	feet per minute
g	G load factor
hr	hour(s)
lb	pound(s)
mph	miles per hour
MSDS	material safety data sheets
nm	nautical miles
RCMP	Royal Canadian Mounted Police
TSB	Transportation Safety Board of Canada
TSO	Technical Service Order
UTC	Coordinated Universal Time
VFR	visual flight rules
'	minute(s)
"	second(s)
°	degree(s)
°M	degrees of the magnetic compass
°T	degrees true

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