Aviation Safety Investigation Report 199502371

Cessna Aircraft Company 310R

28 July 1995

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Aviation Safety Investigation Report

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Occurrence Number: 199502371 **Occurrence Type:** Accident
Location: 19km NNE Coolamon
State: NSW **Inv Category:** 3
Date: Friday 28 July 1995
Time: 1949 hours **Time Zone** EST
Highest Injury Level: Fatal
Injuries:

	Fatal	Serious	Minor	None	Total
Crew	1	0	0	0	1
Ground	0	0	0	0	0
Passenger	3	0	0	0	3
Total	**4**	**0**	**0**	**0**	**4**

Aircraft Manufacturer: Cessna Aircraft Company
Aircraft Model: 310R
Aircraft Registration: VH-MFK **Serial Number:** 310R-0130
Type of Operation: Charter Passenger
Damage to Aircraft: Destroyed
Departure Point: Longreach QLD
Departure Time: 1537 EST
Destination: Wagga Wagga NSW

Crew Details:

Role	Class of Licence	Hours on Type	Hours Total
Pilot-In-Command	Commercial	3585.0	20790

Approved for Release: Tuesday, April 15, 1997

FACTUAL INFORMATION

History of the flight

The Cessna 310R aircraft had been chartered to transport livestock buyers, and had flown from Wagga to Longreach on the afternoon of 27 July 1995. The three passengers and the pilot stayed overnight. The following morning the pilot had breakfast at about 0645EST. He was apparently well rested and appeared to be in good health. At about 0800 the aircraft departed Longreach and was flown to a number of properties in the Muttaburra and Julia Creek areas. This entailed a total of some 3 hours flight time before returning to Longreach at about 1500, where the aircraft was refuelled to maximum capacity. The pilot also obtained appropriate weather forecasts and route data, and submitted flight details to the Brisbane briefing office for an instrument flight rules flight to Wagga via Cunnamulla, Bourke, and Condobolin, at a cruising altitude of 9,000 ft. The estimated flight time was 248 minutes.

The pilot reported taxiing at Longreach at 1535 and subsequently advised a departure time of 1537. Normal position reports were made throughout the flight. At 1900, as the aircraft approached Condobolin, the pilot requested, and received, a report of the actual weather conditions at Wagga. The report indicated the wind was light and variable, and that there were 4 octas of cloud at 2,000 ft and 5 octas of cloud at 3,000 ft, with visibility greater than 10 km, reduced in isolated rain showers.

The aircraft passed over Condobolin at 1914, maintaining 9,000 ft, estimating Wagga at 1954. The pilot was requested by Sydney Flight Information Service (FIS) to contact Melbourne FIS. This was carried out at 1919:30 when the pilot reported maintaining 9,000 ft. Melbourne FIS advised the pilot to expect entry to Wagga controlled airspace on descent to 6,000 ft, and to contact Wagga Tower at 25 NM. This was acknowledged by the pilot.

At 1943 the pilot advised Melbourne FIS that the aircraft was 40 NM from Wagga and leaving 9,500 ft on descent. Shortly after, at 1943:35, Melbourne FIS asked him to repeat his DME (distance measuring equipment) distance from Wagga, to which the pilot replied "about 37 DME". That was the last recorded radio transmission from VH-MFK. At 1948:46, three short bursts of hash and one click were heard, lasting for about 5 seconds. The pilot subsequently failed to contact Wagga Tower as required. Communications checks by both Melbourne and Wagga failed to re-establish contact with the aircraft. Search-and-rescue procedures were initiated which resulted in the wreckage of the aircraft later being found 55 km NNW from Wagga Airport, in a cleared field, in lightly timbered, generally level country.

It was subsequently reported that the wife of the pilot had made a telephone call from her home at Narrandera to one of the passengers, as the aircraft approached Wagga. The passenger handed the mobile telephone to the pilot, who told his wife, "I am in big trouble, I've lost my gyros". He indicated he may have to divert to Narrandera, but was informed that the weather was not good there, either. His wife said she would go down to the airport at Narrandera and call him back. After a brief farewell the pilot terminated the call and some 10 seconds later his wife, who was monitoring the radio, heard him report at 37 DME.

A pilot flying from Broken Hill in a similar aircraft type had landed at Wagga some 20 minutes prior to the accident. He reported that, at his cruising altitude of 9,000 ft, he had generally been above cloud, but had occasionally flown through the tops of larger build-ups. The night had been very dark and the only ground lights he had observed were from Leeton. There had been little turbulence apart from the "odd bump", and he had observed only light rime icing on the airframe at cruising altitude. This had rapidly dissipated during descent through 7,000 ft.

Some time after 2000 he was requested to assist in the search for the missing Cessna. After taking off from runway 23 at Wagga, he entered cloud at about 1,000 ft and flew out along the expected inbound track of the aircraft to a distance of about 35 NM, at an altitude of 4,000 ft. He had then searched the area between 35 NM and 25 NM for about 20 minutes. At no stage during the time he was in the search area did he see the ground or any other feature.

The wreckage of the aircraft was strewn over an area of some 250 m by 300 m in a pattern consistent with an in-flight, high speed breakup, at a low height. Apart from the rudder tab, all structural components and flight controls were accounted for at the accident site, including a 0.5 square metre section of the left horizontal stabiliser lower skin, which was located some 450 m to the south-west of the main wreckage area. From the depth of the impact craters, and orientation of ejected earth, it was apparent that the wreckage had been travelling at high speed on impact, in a north-east direction. The disposition of the tail components indicated they had separated first in the break-up sequence. The aircraft had then disintegrated prior to ground impact. This was indicated by the wreckage scatter and divergent paths of heavier components. There was no evidence found to indicate the presence of any pre-existing structural deficiency prior to the accident. Both engines had suffered considerable impact damage but had probably been at a low power setting at the time of impact. This was consistent with damage observed to the propeller blades. Evidence was found to indicate that all four fuel tanks had contained fuel at the time of impact.

All four occupants had suffered multiple injuries in the accident. The extent of aircraft damage made the accident non-survivable. Each of the three passengers had been ejected from the aircraft before it struck the ground, as a result of massive structural disruption of the airframe. None of the passenger seatbelts found in the wreckage showed evidence of having been fastened at the time of impact.

During an in-flight telephone conversation about 3 minutes prior to the accident, the pilot had indicated that the gyroscopic flight instruments had failed. Both attitude indicators and the directional indicator were air-driven gyro types. The turn co-ordinator was electrically operated. A post-accident examination of both attitude indicators showed no evidence of rotational witness marks which would have been expected if the gyros had been rotating at impact. The directional indicator gyro casing did display a witness mark consistent with the gyro being stationary at impact. Although it could not be determined if the turn co-ordinator gyro had been rotating at the time of the occurrence, electrical power was maintained until aircraft break-up.

The aircraft was equipped with two vacuum pumps, one driven by each engine, to provide a vacuum source for the air-driven gyroscopic flight instruments. The right engine driven vacuum pump body was found on the ground in the area between the engines. The left engine driven vacuum pump was found complete, together with its drive coupling, in the crater of the main wreckage. No useful information was obtained from the remains of the right engine vacuum pump. The left engine vacuum pump was dismantled and the internal vanes were found broken, possibly resulting in seizure of the pump and subsequent shearing of the drive coupling. Further investigation indicated that the engine had continued to operate after the drive coupling had sheared. When that event took place could not be determined. It is likely that the right vacuum pump drive had also sheared in flight; however, this could not be substantiated as the drive coupling was not recovered. An examination of the remaining vacuum system components found no evidence of any pre-existing defect.

The loss of vacuum to the air-driven gyroscopic flight instruments would have resulted in those instruments providing erroneous and misleading aircraft attitude and heading indications to the pilot. A search of the BASI database found that four occurrences of double vacuum pump failure in twin-engine aircraft had been reported in Australia during the past 10 years.

A similar search was made of records held by the National Transportation Safety Board (NTSB) of the United States of America. In the period 20 May 1983 to 1 March 1994, the NTSB investigated 29 accidents in which vacuum system failure and/or vacuum pump malfunction were contributing factors. One accident involved a twin-engine aircraft suffering a double vacuum-pump failure. The remaining 28 accidents involved single engine aircraft. Most accidents resulted from the pilot losing control of the aircraft in instrument meteorological conditions (IMC), following the loss of reliable indications from the air driven gyroscopic flight instruments.

ANALYSIS

The circumstances of this accident were consistent with a loss of control by the pilot during flight at night in IMC, which resulted in the structural limitations of the aircraft being exceeded.

The pilot was reported to have told his wife, during an inflight telephone conversation that "I've lost my gyros". This was indicative of a failure of the vacuum-driven gyroscopic flight instruments. Examination of both attitude indicators and the directional indicator showed their respective gyros were not rotating at the time of impact. An examination of the vacuum system found that, with the exception of the vacuum pumps, it had been capable of normal operation immediately prior to impact. Only the left vacuum pump was recovered, and was found to have failed prior to impact. From the evidence available, it is concluded that the right vacuum pump had also failed some time prior to impact.

Despite extensive enquiries, no evidence was found to indicate the vacuum system was other than capable of normal operation when the aircraft departed Longreach for Wagga. There was no evidence found of any event during the subsequent flight which could have indicated when, or in what sequence, the vacuum pumps failed. With the benefit of hindsight, the only indication of a possible problem was the unexplained change in cruising altitude from 9,000 ft to 9,500 ft after the aircraft had passed over Condobolin. This could suggest that the pilot had already lost the use of his gyroscopic flight instruments and was endeavouring to remain above cloud until ready to commence descent into Wagga. At no stage did the pilot indicate to FIS that he was experiencing problems.

The pilot was faced with a relatively straight descent into Wagga, utilising the remaining flight instruments. Those instruments were, by their very nature, subject to various errors resulting from manoeuvres and other accelerations during flight. Such errors would be manifested as false, short-term indications. In normal instrument flying, those false indications could be resolved by reference to the gyroscopically stabilised attitude indicators or directional indicators.

Instrument-rated pilots are required to demonstrate proficiency in controlling their aircraft in normal flight manoeuvres and unusual attitude recovery techniques, with sole reference to the remaining flight instruments following a simulated failure of the primary attitude indicator. Normally, the failure is simulated by covering the instrument face. However, the person conducting the proficiency check is not permitted to simulate a failure of the primary attitude indicator in IMC or at night, unless that person has in view another serviceable attitude indicator. Furthermore, if a standby attitude indicator, powered from a different source to that of the primary attitude indicator, is available, then the person demonstrating proficiency is permitted to refer to the standby attitude indicator. There was no provision for the fitment of a standby attitude indicator to this class of aircraft.

In this occurrence the pilot was faced with the failure of both attitude indicators, as well as the directional indicator. Moreover, there was extensive cloud and rain on the intended descent track, the night was very dark, and there would have been almost no external visual cues to assist the spatial orientation of the pilot. In addition, the descent was at the end of a long and probably tiring day. Unfortunately, as distinct from a proficiency check, it is unlikely that the attitude and directional indicators were covered. In the course of his normal instrument scan, the pilot could not have avoided seeing erroneous attitude and heading indications from the failed instruments. His instrument scan pattern would have been developed over many thousands of flying hours, with great reliance on the attitude indicator. Such a habit could not easily have been modified to ignore the very powerful stimuli from the now unreliable attitude indicator. As a result, it is considered that the pilot, despite his very considerable experience, encountered circumstances that were beyond his capabilities. During the descent in IMC the pilot became spatially disorientated, leading to the loss of aircraft control, and in-flight break-up.

SIGNIFICANT FACTORS

1. The probable in-flight failure of both engine-driven vacuum pumps, resulting in a loss of supply to the air-driven gyroscopic flight instruments.

2. Unreliable aircraft attitude and directional indications from the air driven gyroscopic flight instruments, which adversely affected the ability of the pilot in command to safely control the aircraft by sole reference to the remaining flight instruments.

3. Adverse meteorological conditions which prevented the pilot in command continuing the flight by visual reference to the natural horizon or other external features, following the loss of credible indications from the air-driven gyroscopic flight instruments.

SAFETY ACTION

As a result of the investigation into this occurrence, the Bureau of Air Safety Investigation issued interim recommendation IR950059 to the Civil Aviation Safety Authority (CASA) on 21 October 1996:

"The Bureau of Air Safety Investigation recommends that the Civil Aviation Safety Authority ensure appropriate maintenance policies are developed for all general aviation aircraft pneumatic vacuum system components".

The CASA response received on 13 February 1997 stated:

"I refer to your BASI Interim Recommendation IR960059 concerning the accident invloving Cessna 310R, VH-MFK on 28 July 1995. The following comments are forwarded for your consideration.

"Upon receipt of this Interim Recommendation, CASA was alerted that maintenance requirements for pneumatic check valves had been introduced by Airborne Air and Fuel Products.

"An article is being prepared for inclusion in Flight Safety Australia informing all Certificate of Registration holders that periodic testing of specific vacuum components is recommended by the component manufacturer.

"An Airworthiness Advisory Circular will be issued to inform operators that failure to carry out periodic testing could result in unreliable indications or loss of aircraft flight instruments during IFR flight. This AAC will recommend that functional testing of the vacuum and pressure valves be included in the aircraft maintenance schedule."

Response status: CLOSED - ACCCEPTED

In addition, the Bureau issued safety advisory notice SAN960145 to the Civil Aviation Safety Authority on 13 February 1997:

"The Bureau of Air Safety Investigation advises the Civil Aviation Safety Authority of the availability of standby and alternative power sources for air driven gyroscopic flight instruments used in commercial IFR operations. An example of such a standby attitude reference system is the SVS III manufactured by Precise Flight Inc. This system utilises engine manifold pressure as a standby power source.

"The Authority should review the requirements for attitude indicators and examine the availability of alternative power sources. Also, during instrument ratings and renewals, pilots should be warned of the distractions caused by erroneous attitude indications and be encouraged to cover these instruments in the event of a failure."