Aviation Safety Investigation Report 199402904

Cessna Aircraft Company Super Skymaster

09 October 1994

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Aviation Safety Investigation Report

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Occurrence Number: 199402904 **Occurrence Type:** Accident
Location: Walgett
State: NSW **Inv Category:** 3
Date: Sunday 09 October 1994
Time: 1550 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: 337A
Aircraft Registration: VH-DRI **Serial Number:** 3370514
Type of Operation: Non-commercial Pleasure/Travel
Damage to Aircraft: Destroyed
Departure Point: Walgett NSW
Departure Time: 1540 EST
Destination: Walgett NSW

Crew Details:

Role	Class of Licence	Hours on Type	Hours Total
Pilot-In-Command	Commercial	102.0	3200

Approved for Release: Tuesday, April 23, 1996

1. FACTUAL INFORMATION

History of the Flight

The aircraft had returned to Walgett late on the afternoon of the day before the accident, having completed a five-day charter to the Gulf of Carpentaria.

On the day of the accident the Walgett Aero Club held a barbecue and flying competition. The pilot of the Cessna 337 indicated that he did not intend to take part in this competition. Later in the day, he advised the flying instructor who was supervising the flying competition that he wished to carry out a low pass over the aerodrome. The instructor had no objection to this request.

At approximately 1550 hours the pilot took off from runway 18 with three passengers. After what appeared to be a normal circuit and approach, the aircraft made a high-speed pass, with the landing gear retracted, parallel to runway 18 at approximately 20-30 ft above ground level (AGL) .

At 100-150 m from the runway intersection, witnesses observed the aircraft enter a steep climb. Witness estimates of the attitude adopted by the aircraft ranged from 40 to 70 degrees nose-up. The aircraft remained in this high nose attitude for 6-10 seconds until an altitude of approximately 700-1,000 ft AGL was reached.

At this point the aircraft's left wing dropped, the nose lowered steeply, and witnesses noted that the engine noise reduced significantly. The instructor supervising the competition stated that after the aircraft appeared to stall, he saw the rudder surface on the tailplane fully deflect in a direction opposite to the observed rotation. The aircraft rotated slowly to the left in an extreme low-nose attitude. Another witness commented that when the aircraft had descended to approximately 200-300 ft AGL, it appeared to adopt a slightly higher nose attitude. This change of attitude was transitory. The nose attitude lowered again quickly and the aircraft impacted the ground in a very steep nose-down attitude.

Wreckage Examination

The wreckage was located on the Walgett aerodrome, 42 m to the south of the runway strip markers of runway 36.

The aircraft had impacted the ground in a steep nose-down attitude, wings level, with negligible rotation after impact. It did not slide along the ground after impact. The structural deformation was related to the onset of impact loads.

All aircraft extremities, including doors and all control surfaces, were present in the wreckage.

Technical examination of the engines and propellers showed them to be capable of normal operation prior to the impact. No indication was found of any aircraft system malfunction which may have contributed to the accident. However, destruction of the cockpit and the instruments precluded the individual systems' pre-impact status being determined.

The accident was not survivable.

Pilot Information

The pilot was the holder of a commercial pilot licence (aeroplanes). He held a valid medical certificate with a requirement to wear glasses. He was also the aircraft owner. He held an air operator's certificate, re-issued by the Civil Aviation Authority on 30 June 1994, which allowed him to carry out charter operations in VH-DRI.

The last entry in the pilot's logbook was made on 23 August 1994. At this time he had accumulated approximately 3,200 hours total flight time (3,100 hours in single-engine aircraft and 3,050 hours as pilot in command).

The pilot had completed his endorsement training on the C337A on 11 June 1994. This was his first multi-engine endorsement. At the time of the last logbook entry, he had accumulated 102 hours in the aircraft type, most of which was in VH-DRI.

On 27 June 1994 the pilot undertook a flight check with a Civil Aviation Authority flying operations inspector in order to complete his chief pilot requirements and to include the C337A on his air operator's certificate. On this occasion it was considered that the pilot met requirements but was to complete further training in the handling of emergency procedures. The CAA pilot file notes that an approved air test officer completed this training and advised that the pilot's handling of emergency procedures was satisfactory. The variation on the air operator's certificate was issued on 30 June 1994.

Post-mortem examination of the pilot revealed the presence of marked atherosclerosis of the coronary artery but there was no evidence of a coronary occlusion. Some alcohol was detected in liver and muscle fluid which was used for testing as sampling of blood or vitreous humour was not possible.

Weather

The weather on the day of the accident was mild with a temperature of 23 degrees C. A high-pressure system was located over south-east Australia. The sky was clear and there was a gentle breeze from the south-west of up to 5 kts. The visibility was good.

2. ANALYSIS

Aircraft Handling Characteristics

Cessna aircraft are generally docile in most areas of handling. A number of pilots who had extensive experience on the C337, including flight instructors, agreed that placing the aircraft in the attitude that was witnessed on the day of the accident would have resulted in a much more aggravated stall than would be experienced as a result of a stall from straight and level flight. Witness statements agree that the aircraft was being operated at or near full power during the manoeuvre. It could not be ascertained whether the pilot reduced power before or after the point of the stall.

As the aircraft was seen to adopt and maintain a very high nose attitude, the stall that resulted would have occurred quickly due to the rapid loss of airspeed. The height required to recover from such a stall would have been significant and probably greater than that which was available.

The observed full deflection of the rudder surfaces was consistent with the actions of a pilot who may have been attempting to counter an incipient spin.

The C337A was certified under the United States Civil Aviation Regulations Part 3 which preceded the Federal Aviation Regulations Part 23. As this aircraft was considered a multi-engine aircraft, it was not required to undergo spin testing as part of its type certification. Consequently, no data is available to indicate the typical height loss expected as the result of a spin.

VH-DRI was certified for operations in the normal category. The flight manual stated that operation shall be limited to normal flying manoeuvres but may include straight and steady stalls and turns in which the angle of bank to the horizontal is 60 degrees or less. Other acrobatic manoeuvres shall not be performed.

The Australian Civil Aviation Regulations define aerobatics as "manoeuvres intentionally performed by an aircraft involving an abrupt change in its attitude, an abnormal attitude, or an abnormal variation in speed". A glossary of aeronautical terms used for accident investigation by the US Department of Transportation Safety Institute, Oklahoma, defines an aerobatic manoeuvre as "a pre-planned flight manoeuvre in which the aircraft exceeds either 60 degrees of bank or 30 degrees of pitch".

The observed manoeuvre is consistent with the pilot's probable intention to attempt a wingover or possibly a stall turn. By any of the above definitions, wingovers and stall turns are aerobatic manoeuvres and are outside the normal flight envelope for this aircraft type.

Fuel System

VH-DRI was equipped with a main fuel tank of 174 litres usable fuel capacity in each outboard wing panel and a sump tank of 2.7 litres fuel capacity in the lower portion of each tail boom. Fuel flows to the sump tanks via two outlets in each main tank, one at the bottom forward edge and one at the bottom rear edge of each tank. Fuel then flows from the sump tanks through a bypass in each electric auxiliary fuel pump (when the pump is not operating) to selector valves located at the wing roots.

The inclusion of sump tanks reduces the risk of interruption of the fuel flow when the aircraft is placed in a range of flight attitudes including those that were witnessed during the accident. Had fuel been unable to drain from the main cells to the sump tanks due to the observed manoeuvre, it would have taken approximately two minutes and thirty seconds to unport the fuel lines in the sump tanks with the aircraft operating at full power, assuming that the sump tanks were full at the time the aircraft entered the nose-high attitude. As witnesses reported that the elapsed time between the aircraft entering the pull-up and the nose lowering at the top of the manoeuvre did not exceed 10 seconds, it is unlikely that engine failure would have occurred as a result of interruption to the fuel flow due to unporting of the fuel outlets from the main fuel cells.

VH-DRI was also equipped with an optional auxiliary fuel tank (68 litres usable capacity) in each wing between the cabin and the tail boom. The auxiliary tanks feed directly through the engine-driven fuel pump to the engine. The fuel from each auxiliary tank drains via a single outlet near the bottom of the tank approximately half way between its forward and aft edges.

If the auxiliary tanks were selected it might be possible, at very low fuel levels, to unport the outlet to the tanks if the aircraft were in a very nose-high attitude for a considerable length of time.

The C337A engine is fuel injected. The fuel injection system delivers fuel, under pressure, to the inlet manifolds of the engine and is unlikely to be affected by the placement of the aircraft in unusual attitudes.

It was not possible, due to the severity of the damage, to accurately determine the position of the fuel selectors in the cockpit prior to impact. The flight manual stated that main fuel tanks should be selected for takeoff, landing and the first 60 minutes of flight. It is therefore most likely that the main tanks were selected for this flight. Calculations have determined that there was approximately 150 litres of fuel on board the aircraft prior to its last flight. It was also not possible to accurately determine the quantities of fuel in each tank as every fuel cell was ruptured on impact with little or no fuel being observed in each cell. Nonetheless, it is unlikely that either engine failed due to fuel starvation.

Weight and Balance

Calculations of the weight and balance of the aircraft were based on the following:

1. The pilot was in the front left pilot seat while the three passengers occupied the right front seat and the two centre seats directly behind.

2. According to fuel agent records, the pilot purchased fuel at Birdsville but did not puchase fuel after return to Walgett. The aircraft flew direct from Birdsville to Walgett, a flight time of four hours. Assuming full tanks at Birdsville and a fuel consumption of 85 litres per hour (based on the pilot's operating handbook), fuel remaining at Walgett was calculated at 154 litres. After return to Walgett the pilot told the passengers that the aircraft had consumed 90 litres per hour. The pilot also informed the instructor supervising the flying competition that the aircraft had approximately 150 litres of fuel on board.

3. A bag of flour was found in the cabin area of the aircraft. It was estimated to have weighed 20 kg.

Using these figures it was determined that the aircraft was within weight limits but that the centre of gravity (c.g.) was outside limits, marginally forward of the c.g. envelope.

Having more or less fuel on board would not have significantly affected this result, with the c.g. close to or just forward of the c.g. envelope. The only factor that would have made a significant difference to the position of the c.g. would have been the seating position of the passengers. Had they been seated in the rear row of seats or some combination of centre and rear seats, the position of the c.g. would have moved to within the envelope.

Despite this finding, discussions with C337 pilots indicate that it is unlikely that the forward position of the c.g. had a significant effect on the handling characteristics of the aircraft.

Seat Mechanism

There have been documented occasions when control seats have dislodged from their previously locked position and moved backwards when loads have been imposed by rotation for take-off, or by g-loads in aerobatic manoeuvres or in turbulence. This has been attributed to excessive wear in the seat adjustment mechanism.

A sudden rearward movement of the seat could make it difficult for the pilot to reach the control column. There is also the possibility that the pilot could instinctively grab at the control column in an attempt to counter the seat movement, causing an abrupt nose-up change in attitude.

The Civil Aviation Authority issued an Airworthiness Directive (AD) in relation to the seat adjustment mechanism in September 1988 (AD/CESSNA 337/27 Amt. 1 Seat Adjustment Mechanism). This AD was required as a periodic inspection every 100 hours or 12 months, whichever occurred earlier.

The aircraft logbook indicated that the AD had been complied with. The most recent inspection was carried out on 5 July 1994, approximately three months prior to the accident.

Due to the severity of the damage to the cockpit area, it was not possible to determine if the seat had dislodged, in flight, from the desired position.

Pilot Performance

Estimates of any degree of pilot performance degradation due to the presence of alcohol in liver and muscle tissue should be treated with caution. It was therefore not possible to accurately determine the blood alcohol level.

There was no evidence to suggest that the pilot had consumed alcohol on the day of the accident.

There was no evidence that pilot incapacitation was a factor in the accident.

Weather

The weather was not considered to be a contributing factor to this accident.

Summary

As the aircraft was observed to adopt a very nose-high attitude and to sustain it, airspeed would have reduced significantly. As the pilot attempted to turn out of the nose-high attitude, the observed subsequent flight path of the aircraft was consistent with a stall and spin. The altitude of the highest point in the flight path was insufficient to permit the pilot to effect a recovery from a spin.

Loss of engine power at or near the highest point in the flight path would have reduced the power available during the manoeuvre intended to bring the aircraft out of the nose-high attitude. This could have increased the rate of airspeed loss and may have slightly advanced the time at which control was lost. It is doubtful, however, that an engine failure would have precipitated the loss of control.

3. CONCLUSIONS

Findings

1. The pilot held a valid licence and was endorsed on the aircraft type.

2. The pilot carried out a manoeuvre for which the aircraft was not certified.

3. The aircraft appeared to stall at the highest point in its flight path.

4. The aircraft descended in a steep nose-low attitude and impacted the ground shortly after.

5. The aircraft was within maximum weight limits.

6. The centre of gravity of the aircraft was marginally forward of the forward limit of the c.g. envelope.

7. The engines and propellers were capable of delivering power prior to impact.

8. No other pre-existing airframe or system malfunction that could have directly affected the flight was found.

9. There was no evidence of a medical condition that could have affected the pilot's ability to control the aircraft.

Significant factors

The pilot lost control of the aircraft at an altitude which was insufficient to permit a recovery before the aircraft impacted the ground.