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ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2010-079

Final

Collision with terrain, VH-VSK 2 km NNE of Durham Downs Homestead, Queensland 18 October 2010

Abstract

At about 1030 Eastern Standard Time on 18 October 2010, a Cessna Aircraft Company 172S aircraft, registered VH-VSK, was operating at low level near Durham Downs Homestead, Queensland. A pilot and one passenger were on board.

The pilot was assisting a ground party locate two horses. The aircraft was seen manoeuvring at low level before radio and visual contact was lost. A search later found that the aircraft had impacted terrain near a dry creek bed. Both occupants received fatal injuries and the aircraft was seriously damaged.

The aircraft's impact attitude was consistent with a loss of control following aerodynamic stall. The pilot was reported to have told another pilot a few days before the occurrence that the aircraft's stall warning system was inoperative. However, the status of the stall warning system at the time of the occurrence could not be confirmed. The investigation identified some other issues which also could have influenced the safety of the flight.

The aircraft operator introduced a number of changes to its policies and procedures following the occurrence.

FACTUAL INFORMATION

History of the flight

At about 1030 Eastern Standard Time[1] on 18 October 2010, a Cessna Aircraft Company 172S aircraft, registered VH-VSK, was operating near Durham Downs Homestead, Queensland (Qld). The pilot and one passenger were on board the flight. Earlier that morning, the pilot flew the passenger from Durham Downs Homestead to Woomanooka, about 40 km to the south-east to repair a disabled truck. During the return flight, and within a few kilometres of the homestead, the aircraft was heard by a ground party, on motor cycles, that was herding horses. The pilot was asked via radio by a member of the ground party to see if he could locate two horses that had separated from the main group. The pilot agreed to the request.

Members of the ground party estimated that the aircraft was about 1 km from their position at that time. They observed it flying low above the treetops and turning steeply. Shortly after, the pilot broadcast that he had located the two horses and suggested that the ground party 'get moving with the horses'. The ground party turned their

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

focus back to the main group of horses and paid no further attention to the aircraft. They could not hear the aircraft because of the motor cycle engines.

A few minutes later, a member of the ground party observed two horses emerge from under some trees. That person could no longer see the aircraft and, feeling some concern, attempted to contact the pilot via radio. However, there was no reply.

The ground party immediately initiated a search and subsequently located the aircraft wreckage near a dry creek bed in the area where it was last seen. When they arrived at the accident scene, they detected a strong smell of aviation gasoline and observed fuel leaking from the aircraft's wing fuel tanks.

The pilot and passenger were fatally injured and the aircraft was seriously damaged.

Members of the ground party stated that the weather conditions at the time of the occurrence were fine, with a light wind. They did not notice anything abnormal in terms of the aircraft's operation or the pilot's radio broadcasts. No other person observed the aircraft during the period immediately preceding the occurrence.

It was reported that there had been an argument between the pilot and a person at Woomanooka before the aircraft departed on the occurrence flight. That person recalled that he spoke sternly to the pilot about 'saying things behind his back'. Afterwards, he and the pilot and others had morning tea together. The pilot did not appear withdrawn or otherwise to have reacted adversely to the episode in the period before the aircraft departed for Durham Downs.

Pilot information

The pilot held a Commercial Pilot (Aeroplane) Licence, a mustering endorsement and a Grade 2 Flight Instructor rating. His total flying experience was about 1,500 hours. His flight crew record indicated that he completed low-flying training and was endorsed to conduct aerial mustering operations on 5 November 2008. The pilot flew the aircraft regularly and had been employed as a pilot at Durham Downs for about 2 years.

On 19 June 2010, the pilot was appointed senior pilot for the company which owned the aircraft and three other Cessna 172 aircraft. That position included responsibility for all of the company's air operations.

The pilot held a valid Class 1 Medical Certificate. The certificate included the restriction that reading correction was to be available whilst exercising the privileges of the licence.

Witnesses reported that, on 11 and 12 October 2010, the pilot had experienced flu-like symptoms, including a fever and a very sore throat. He was examined by a paramedic at Bellara, Qld on 13 October and prescribed antibiotics.

On 14 October, the pilot drove a vehicle from Durham Downs to Woomanooka. That journey normally took 3 to 4 hours but flooding in the area at the time made some roads impassable. On this occasion, the journey was reported to have taken longer than 12 hours and the pilot did not arrive at the destination until late that night. The following morning, the pilot drove another vehicle back to Durham Downs, arriving around lunchtime.

The pilot's fever was reported to have gone by 16 October but he appeared 'pretty tired' that day. Other than attending to some paperwork, the pilot undertook no other work activities on 16 October.

The pilot was reported to have slept in on 17 October and completed some paperwork that morning before having the afternoon off. The pilot was in bed by 2100 that night and rose at about 0430 on 18 October.

Passenger information

The passenger was a motor vehicle mechanic and had no experience as a pilot. He was reported to have travelled in the aircraft on about six occasions during the 20 months he had been employed at Durham Downs, including with the occurrence pilot. None of those previous flights were mustering flights.

Aircraft information

The aircraft (serial number 172S 8648) was manufactured in the United States in 2000. It was one of four Cessna 172 aircraft owned and operated by a pastoral company on properties across Australia. The company reported that the average flight time for each aircraft in 2010/2011 was about 367 hours.

At the time of the occurrence, the aircraft had current certificates of registration and airworthiness and a valid maintenance release.

The last scheduled 100-hourly maintenance check was carried out on 23 July 2010. The aircraft was being maintained in accordance with Civil Aviation Safety Authority (CASA) Maintenance Schedule 5. The engine was maintained under AD/ENG/4 Piston Engine Continuing Airworthiness Requirements (AD/ENG/4). For private and aerial work operations, AD/ENG/4 allowed piston engines to be maintained 'on condition' beyond the engine manufacturer's overhaul time, provided certain periodic checks were undertaken. At the time of the occurrence, the engine had exceeded the engine manufacturer's overhaul time of 2,000 flight hours by 107 hours.

The maintenance release was recovered from the aircraft at the accident site. There were no entries in the maintenance release regarding any aircraft defects.

In June 2011, the ATSB received a report that, a few days prior to the occurrence, the pilot had told another pilot that the aircraft's stall warning system was inoperative. The other pilot had been based at Durham Downs until about 1 week before the occurrence.

Neither the aircraft owner/operator nor the aircraft maintenance organisation received any information regarding the serviceability of the stall warning system prior to 18 October 2010.

The manager of Durham Downs flew in the aircraft with the accident pilot prior to 18 October but was unsure of the date. He recalled that the stall warning had sounded during a mustering manoeuvre and made comment to the pilot about it. He also recalled the stall warning sounding during the landing from the flight.

The other pilot flew the aircraft regularly during the previous 4 months, including for 1.2 hours on 11 October 2010. He did not recall any fault in the stall warning system during that flight. The occurrence pilot flew the aircraft for 1.3 hours on 13 October 2010. According to the maintenance release, that was the last flight by the aircraft before the flights on 18 October.

No other information was available regarding the status of the stall warning system at the time of the flight.

Stall warning system serviceability - regulatory aspects

Civil Aviation order (CAO) 20.18.3.4 specified the instrumentation required for flight under visual flight rules (VFR) for aircraft in private, aerial or charter operations. It stated that an aircraft may only be operated under the VFR provided it was equipped with certain flight and navigational instruments, and any other instruments and indicators specified in the aircraft's flight manual. In common with other Australian civil registered aircraft, the applicable aircraft flight manual showed the stall warning system as required equipment. In other words, a serviceable stall warning system was a mandatory condition for flight.

CASA advised that it had no record concerning the issue of a Special Flight Permit or Permissible Unserviceability for operation of the aircraft with the stall warning system inoperative. Further, it advised that it could not imagine any circumstances where such a permit for the aircraft type would be issued.

Cessna 172S stall warning system

The Cessna 172S Pilot's Operating Handbook (POH), Section 7-46, included the following description of the aircraft's stall warning system:

> STALL WARNING SYSTEM
>
> The airplane is equipped with a pneumatic type stall warning system consisting of an inlet in the leading edge of the left wing, an air-operated horn near the upper left corner of the windshield, and associated plumbing. As the airplane approaches a stall, the low pressure on the upper surface of the wings moves forward around the leading edge of the wings. This low pressure creates a differential pressure in the stall warning system which draws air through the warning horn, resulting in an audible warning at 5 to 10 knots above stall in all flight conditions.

Stall warning system checks

Section 4-11 of the POH included a description of the pre-flight check of the stall warning system as follows:

> 2. Stall Warning System – CHECK for blockage. To check the system, place a clean handkerchief over the vent and apply suction; a sound from the warning horn will confirm system operation.

There was no reference in the POH regarding operation of the aircraft with the stall warning system inoperative.

Stalling characteristics and speeds

The POH included the following description of the aircraft's stalling characteristics:

> **STALLS**
>
> The stall characteristics are conventional and aural warning is provided by a stall warning horn which sounds between 5 and 10 knots above the stall in all configurations.
>
> Power off stall speeds at maximum weight for both forward and aft C.G. [centre of gravity] positions are presented in Section 5.

Section 5-12 of the POH included stall speeds at maximum take-off weight (2,550 lbs (1,157 kgs)), power off, for angles of bank up to 60°, for the most rearward and the most forward centre of gravity (c.g) conditions. The data highlighted the increase in stalling speed as angle of bank increased. For example, for the most rearward c.g condition, the stall speeds in kts indicated airspeed (KIAS) at angles of bank up to 60° with flaps UP and at 10° were:

Table1: Stall speeds in KIAS

	0°	30°	45°	60°
UP	48	52	57	68
10°	43	46	51	61

There were two notes associated with the data:

> Altitude loss during a stall recovery may be as much as 230 feet.
>
> KIAS values are approximate.

Wreckage examination

The aircraft was seriously damaged by the ground impact forces (Figure 1). There was no evidence of fire.

Deformation damage to the wing leading edges indicated that the aircraft's attitude at impact was about 55° nose-down. The right wing sustained more damage than the left, indicating that the right wing impacted the ground before the left wing. The initial impact position was about 4 m from the final location of the wreckage.

Figure 1: Aerial view of the wreckage

There was no evidence of any pre-existing fault in any of the flight control systems. The wing flaps were in the retracted position at impact.

There was no indication that any part of the aircraft sustained a birdstrike or that the aircraft struck a tree or other obstacle prior to the impact with the ground.

The engine crankshaft had fractured immediately behind the propeller. Examination of the crankshaft fracture surfaces revealed evidence of an overload fracture due to severe side loads on one of the propeller blades. Damage to the propeller blades was consistent with the engine delivering power to the propeller at the time of impact.

The airframe fuel filter, which remained secured on the bottom right of the engine firewall, contained a significant amount of uncontaminated fuel. The finger filter in the engine fuel metering unit was clean. There were no blockages or contaminants in any of the fuel injectors.

The engine's spark plugs were clean and appeared functional.

The engine tachometer and the airspeed indicator were removed from the aircraft for further examination. No information regarding the possible speed of the aircraft at impact could be obtained.

Witness marks on the face of the engine tachometer and instrument glass showed that the

tachometer was indicating between 2,100 and 2,300 RPM at impact.[2]

The extent of impact damage and disruption to the left wing, forward fuselage, and cockpit area prevented determination of the pre-impact status of the stall warning system. That included whether there had been any blockage in the system's plumbing.

Medical and pathological information

The post-mortem and toxicology reports on the pilot and passenger were unremarkable.

Survival aspects

Both occupants were wearing lap/sash seat belts at impact. However, the extent of the damage to the occupiable space indicated that the impact was not survivable.

Organisational and management information

Aerial mustering operations

Civil Aviation Order (CAO) 29.10 defined aerial stock mustering as:

> The use of aircraft to locate, direct and concentrate livestock while the aircraft is flying below 500 feet above ground level and for related training operations.

Appendix 1 to the CAO detailed the syllabus of training for aerial stock mustering. Features of the syllabus included, with respect to aircraft handling:

- Level, climbing and descending turns up to 60 degrees angle of bank;
- Review of stalling symptoms and recovery in both wings level and turning flight up to 60 degrees angle of bank;
- Slow flying (including use of flap and the effect of changing flap settings);
- Manoeuvring at varying speeds and angles of bank.

The syllabus included training in flight below 100 ft above ground level and avoidance of obstacles.

With regard to the carriage of passengers during aerial stock mustering operations, CAO 29.10 paragraph 5.2 stated:

> During aerial stock mustering operations a pilot shall not carry more than 1 other person, and that person must be essential to the successful conduct of the operations.

Individuals with expertise in stock behaviour, mustering techniques and/or local geography were examples of persons who could be deemed to be essential to the successful conduct of an aerial mustering operation

Guidelines for pilots

The aircraft owner advised that its pilots were provided with a document prepared in-house in 2005 by a previous company pilot. That document was titled *Fixed Wing Low Level and Stock Mustering Endorsement, Training Notes* and referred to the privileges and limitations of CAO 29.10.

The aircraft owner also advised that, at the time of the occurrence, a document titled *Station Pilot Information, Duties and Procedures*, was 'under development'. The accident pilot, in his capacity as 'senior pilot' had been tasked with preparing the document and had provided company management with a draft copy. The draft included the following statements:

- All operations are to be conducted in accordance with the Civil Aviation Safety Authority (CASA) rules and regulations, regardless of whether or not there is any specific mention of those rules and regulations in this document or any other documents referred to.
- …pilots shall use their own judgement and initiative to ensure that safety standards are not jeopardized and when assessing directions shall not allow themselves to lower operating and safety standards by other influencing factors.

2 The POH for the aircraft stated that the normal cruise RPM range was 2,100 to 2,700 RPM.

- If an aircraft is unserviceable, the issue must be reported to the Senior Pilot and the Pastoral Manager. The plane should be grounded immediately and an aircraft engineer consulted. If necessary, an engineer will attend the aircraft on site to rectify the issue before the aircraft is flown.
- If setting up a mustering configuration:
    1. Reduce power to 2100 – 2200 rpm and set 10 degrees of flaps, this should provide an airspeed of 85-90 knots.

The draft document did not nominate a minimum speed for mustering.

Another pilot who was employed by the company at the time of the occurrence reported that he had never been subjected to any pressure by company management to undertake a flight. In his experience, any safety-of-flight issue raised by a pilot was treated seriously by management and the pilot had the final say on all operational flying matters.

Bird activity

About 2 months previously, the aircraft sustained a birdstrike that resulted in minor damage to the inner portion of the right wing. The accident pilot was flying the aircraft at that time.

The aircraft's maintenance documentation showed that the damage from that birdstrike was repaired by a licensed aircraft maintenance engineer. The on-site wreckage examination revealed that the repair retained its integrity during the impact sequence and was not a factor in the occurrence.

Significant numbers of large birds, including pelicans and eagles, were observed in the area during the on-site phase of the investigation.

ANALYSIS

The extreme nose-down attitude of the aircraft at impact was well outside the normal envelope of operation for the aircraft type. It was consistent with loss of control following aerodynamic stall at an altitude where a ground collision was unavoidable.

The facts relating to the occurrence allowed a number of issues to be eliminated as having directly contributed to the development of the occurrence. The benign weather conditions at the time were unlikely to have caused any control difficulties for the pilot. The wreckage examination did not indicate any fault with the aircraft's engine, its fuel system, or the flight controls that may have led to a loss of control. Further, there was no evidence that the pilot was under any pressure to undertake the flight.

Stall warning system

The evidence relating to the stall warning system; however, was not clear-cut and deserved some discussion.

The investigation considered that the pilot was unlikely to have told the other pilot that the system was inoperative if that had not been the case. In terms of importance and relevance, the pilot would have been aware of the requirement for a serviceable stall warning system, and it was the type of information that one pilot would share with another who flew the same aircraft. At the same time, there was no evidence that the system underwent any repair in the period before the occurrence flight, or that the matter had been reported to company management or the Civil Aviation Safety Authority (CASA). There were, therefore, three possibilities:

- the stall warning system was returned to a serviceable status before the flight, possibly as a result of the pilot removing a blockage in the plumbing
- the pilot operated the aircraft with the stall warning system inoperative
- the stall warning system became inoperative during the occurrence flight.

From the aircraft's maintenance release, and information provided by the other pilot who flew the aircraft, the stall warning system must have become inoperative after the other pilot flew the aircraft on 11 October. The accident pilot could have become aware that the system was inoperative during a routine pre-flight check of the aircraft, or during the flight on 13 October.

The overwhelming majority, if not all, of the pilot's flying experience would have been in aircraft with a serviceable stall warning system and it would be entirely reasonable to expect him to have been aware of the importance of the system to safe flight. Against that background, the investigation considered it less, rather than more likely, that the pilot flew the aircraft with the stall warning system

inoperative. Nevertheless, flight with an inoperative stall warning system could not be discounted entirely.

Stall avoidance during flight with an inoperative stall warning system depended on pilot attention to, and interpretation of, airspeed, aircraft attitude and flight control 'feel'. In situations where a pilot's attention was directed outside the aircraft, the risk of a late and/or inappropriate response to airspeed and attitude changes increased, raising the possibility of an inadvertent aerodynamic stall.

Flight activity when the loss of control occurred

It was apparent from the witness reports that the pilot had been requested to locate the missing horses. The aircraft was then observed manoeuvring (including turning steeply) at low level and the pilot subsequently advised that he had found the horses. Those conditions fell within the definition of aerial stock mustering.

The pilot's suggestion that the ground party 'get moving with the horses' could be interpreted as meaning that the pilot intended to direct or muster the horses towards the main group. Alternately, it could indicate that the pilot was satisfied that the horses were heading towards the main group and reverted to monitoring their progress.

None of the witnesses continued to watch the aircraft after the pilot advised that he had found the horses and 'a few minutes' elapsed before they noticed that the aircraft was missing. In other words, no information was available regarding the aircraft's flightpath during those 'few minutes'; neither was there any information as to when, during that time frame, the loss of control occurred. Against that background, it was not possible to determine whether the pilot continued to 'muster' the horses after advising that he had found them, or to conclude what the aircraft's flight parameters (altitude, speed, and attitude) were when loss of control occurred.

The position of the wing flaps and ad hoc nature of the task

Until the pilot received the request to assist the ground party, the flight entailed a transit from Woomanooka to Durham Downs. The pilot was unlikely to have expected to become involved in 'mustering' activities during the flight. As a result, he may not been mentally prepared for the task and may have forgotten to select 10° of flaps before commencing a low-level manoeuvring flight.

Against the background of the pilot's mustering experience and the aircraft configuration information he had included in the company procedures manual during its draft, it was considered unlikely that the pilot would have deliberately conducted low-level manoeuvring flight in a clean (flaps retracted) configuration. That contrasted with the retracted position of the flaps at impact.

A possible explanation for the as-found position of the flaps was that the pilot, having located the horses and completing the low-level manoeuvring phase of the flight, retracted the flaps to return to the aircraft's clean configuration before continuing on to Durham Downs Homestead.

In any case, with flaps retracted, the aircraft would have stalled at a higher speed than the pilot may have been anticipating for the flight environment at the time. The unexpected nature of such an event, particularly at low level, could have placed extreme pressure on the pilot's capacity to respond appropriately to the situation.

The possibility that the pilot retracted the flaps after he lost control of the aircraft but before ground impact was considered unlikely.

Pilot action to avoid a collision

The pilot may have detected an obstacle in the aircraft's flightpath, such as a large bird or a tree and taken action to avoid a collision. In such a situation, and irrespective of the flaps position, it was possible for one or both wings to have aerodynamically stalled and placed the aircraft in an extreme attitude from which the pilot was unable to recover before ground impact. However, the absence of any direct evidence of the aircraft's flightpath at the time of the occurrence prevented a conclusion that collision avoidance was a factor in the accident.

Residual effects of the pilot's recent illness

Any residual effect from the pilot's recent throat infection, such as reduced alertness or distraction due to pain or physical discomfort, had the

potential to affect the pilot's ability to safely manoeuvre the aircraft. However, no expert medical assessment of his condition had been undertaken since he was prescribed antibiotics on 13 October 2011. Consequently, no positive conclusion could be drawn regarding the pilot's recent illness as a factor in the accident.

Interference with the controls

In the context of the occurrence, the possibility that the passenger interfered with the controls was considered. Any unexpected or unintended movement of the flight or engine controls while the pilot was manoeuvring the aircraft had the potential to cause an in-flight upset and subsequent loss of control. However, considering the passenger's previous experience as a passenger in the aircraft, the likelihood that he interfered with the controls was considered low.

FINDINGS

From the evidence available, the following findings are made with respect to the loss of control and collision with terrain that occurred 2 km north-north-east of Durham Downs Homestead, Queensland on 18 October 2010 and involved Cessna Aircraft Company 172S aircraft, registered VH-VKS. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- For reason(s) which could not be determined, the pilot lost control of the aircraft, probably following an aerodynamic stall.

Other key findings

- The engine was operating at the time of impact.
- The operating status of the aircraft's stall warning system could not be determined.

SAFETY ACTION

Whether or not the Australian Transport Safety Bureau (ATSB) identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this incident.

Aircraft operator

The aircraft owner advised of the following action in response to the occurrence:

> Following the VSK accident, [the operator] reviewed:
>
> - The use of fixed wing aircraft for mustering
> - The type of aircraft used for mustering
> - Pilot training and ongoing monitoring
> - Aircraft Operations Policies and Procedures
>
> It was determined that there was a role for fixed wing aircraft in mustering and it was possible to safely conduct mustering operations. A review of available aircraft types suggested that the Cessna 172 was the most suitable VH registered aircraft for mustering operations. There were a number of non type certified or sport kit aircraft that had good flying performance but these were rejected because of concerns regarding the reliability of construction, maintenance standards and the ability to recruit pilots.
>
> The 172N with the 180Hp motor was determined to be the best of the 172 models due to the higher stall speed and additional weight of sound insulation in the later models. In addition Leading Edge and Vortex Generator (VG) kits were identified as improving mustering performance by lowering stall speed and improving control at low speed. A 172N has been purchased, refurbished and fitted with an 180HP engine, leading edge and VG kits. The remainder of the 172 fleet are progressively being fitted with the leading edge and VG kits.
>
> The standard of pilot training was deemed satisfactory, but a 4 monthly flight check with an instructor was introduced to ensure pilots were maintaining proper standards.
>
> The [company name] Policy and the Station Pilot Information, Duties and Procedures have been revised and reissued, with the latest version July 2011.

SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- a number of witnesses
- the aircraft operator

- the aircraft maintenance organisation
- the Cessna 172S Pilot's Operating Handbook.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the aircraft owner, the aircraft maintenance organisation and the Civil Aviation Safety Authority (CASA).

A submission was received from CASA. The submission was reviewed and where considered appropriate, the text of the report was amended accordingly