Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation
AO-2008-065
Final

Collision with terrain
Luddenham, NSW
24 September 2008
VH-CZX, Liberty Aerospace XL2

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Figure 1: Google Earth

Abstract

On 24 September 2008, at about 1606 Eastern Standard Time, a Liberty Aerospace Incorporated XL2 aircraft, registered VH-CZX, descended through trees and collided with terrain 2 km south of Luddenham, New South Wales. The sole occupant, a student pilot, was fatally injured and the aircraft sustained serious damage.

Air traffic control radar data recordings indicated that the aircraft departed straight and level flight from about 3,000 ft above ground level and descended very steeply at a high rate of descent to below the radar's minimum detection height. Witness observations, aircraft damage and wreckage distribution were consistent with a steep, low-speed collision with terrain.

The investigation was unable to determine the reasons for the departure from straight and level flight or establish the aircraft's movements in the period of time between the loss of radar information and the witnesses' visual observations.

No evidence of any mechanical fault that could have contributed to the accident was found. The weather was benign. A post-mortem examination of the pilot did not identify any pre-existing medical conditions that may have contributed to the accident.

Traces of a cannabis metabolite were present in the pilot's blood, indicating previous use of, or exposure to cannabis. There was no evidence that the pilot was impaired by cannabis at the time of the accident; however, there is extensive evidence that the use of cannabis increases the risk of the impairment of pilot performance.

The investigation did not identify any organisational or systemic issues that might adversely affect the future safety of aviation operations. However, following the accident, the flying school proactively modified its training syllabus to include additional instructional flights on the aircraft type prior to authorising extended solo flights.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

History of the flight

On 24 September 2008, at about 1606 Eastern Standard Time[1], a Liberty Aerospace Incorporated XL2 aircraft (XL2), registered VH-CZX (CZX) collided with terrain 2 km south of Luddenham, New South Wales (NSW). The solo student pilot was fatally injured and the aircraft was seriously damaged.[2] There was no fire.

The pilot had been tasked to fly a solo navigation exercise from Bankstown Aerodrome to Cessnock, NSW and return via a flying training area. The student was also authorised to conduct practice forced landings and practice precautionary search and landings while in the training area, and other exercises including steep turns during the flight.

The pilot departed Bankstown at about 1406 for Cessnock and then returned to the training area, which was outside controlled airspace. Recorded air traffic control radar information showed the aircraft conducting a series of steep turns in the training area, at between 2,900 ft and 3,500 ft above ground level (AGL). At 1605, following a 1-minute period of approximately straight and level flight at about 3,000 ft AGL, the aircraft abruptly descended very steeply at a rate of around 8,800 ft/min to below the radar's minimum detection height of about 800 ft AGL. There were no further radar returns from the aircraft, with impact occurring within about 1 minute of the last return. The aircraft's airspeed could not be determined from the radar information but its groundspeed was estimated[3] at between 67 kts and 95 kts immediately prior to the descent.

Two witnesses reported observing the aircraft immediately prior to the ground impact. The location of those witnesses is shown at Figure 1. Witness 1 reported seeing the aircraft fly slowly at very low level before descending rapidly into trees. Another witness (Witness 2) saw the aircraft 'nose diving towards the ground' with the wings rocking as it descended. From Witness 1's description and the geometry of the accident site, the investigation estimated the aircraft's height in the vicinity of Witness 1 as below 250 ft AGL. A telephone call to the national emergency telephone service to report the accident was recorded around 90 seconds after the time of the last radar return.[4]

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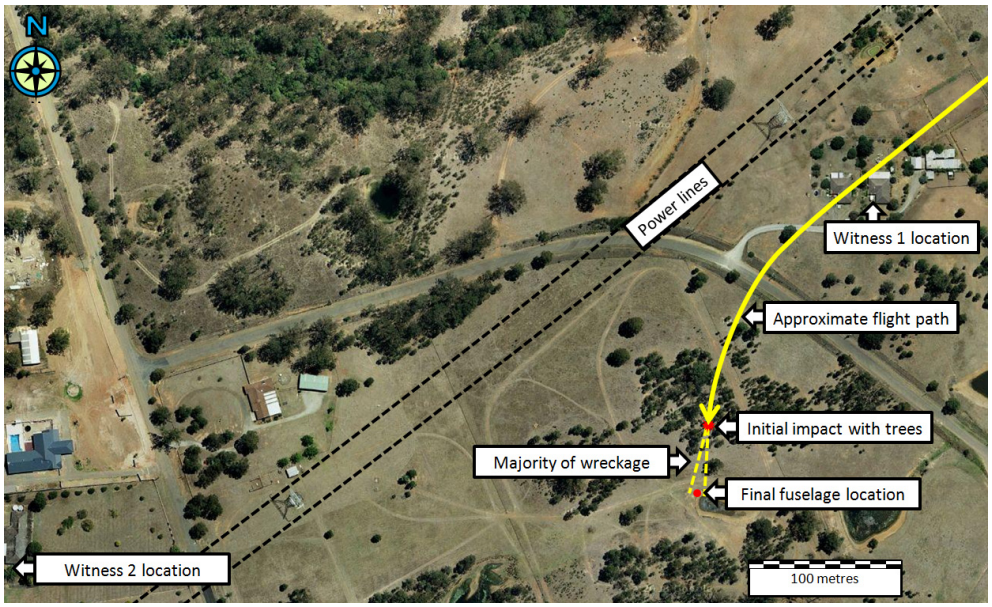
1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 The *Transport Safety Investigation Regulations 2003* definition of 'seriously damaged' includes the 'destruction of the transport vehicle'.

3 Limitations of the radar information prevented a more accurate assessment of the aircraft's groundspeed.

4 The reference clocks for the radar and the national emergency telephone service may have differed.

Figure 1: Witness locations and approximate aircraft flight path



Personnel information

The pilot's qualifications and aeronautical experience is listed at Table 1.

Table 1: Pilot qualifications and aeronautical experience

Licence type	Student Pilot Licence, issued 23 January 2008
Medical certificate	Class 1, valid until 9 April 2011
Total flying hours	74.0
Hours on type	35.9
Solo hours on type	13.2

The pilot had previously completed five solo navigation exercises, all in XL2 aircraft and had conducted steep turns to the required standard while under instruction. The pilot had also undergone flight training in the identification of, and recovery from incipient spins (a flight condition which may lead to a spin[5] if corrective action is not undertaken).

An instructor and two other students who knew the pilot reported that he had been in a good mood in the days preceding the accident. There was no evidence to indicate fatigue was a factor.

[5] A sustained spiral descent with an angle of attack beyond the aircraft's stall angle.

Aircraft information

General

The XL2 was a single-engine, low-wing, composite-fuselage aircraft that was certified in the normal category.[6] CZX was manufactured in the United States (US) in 2008, was first registered in Australia on 3 June that year, and had an estimated 160 hours total flight time at the time of the accident.

The aircraft was powered by Teledyne Continental IOF-240-B5B engine serial number 400167, which drove a two-bladed, fixed-pitch laminated wooden propeller.

It was estimated that the aircraft was within applicable weight and balance limits at the time of the accident.

Aircraft equipment

The aircraft was fitted with a stall warning system, which was designed to provide an aural 'Stall Stall' warning when the aircraft approached or reached an aerodynamic stall condition.

The XL2 aircraft pilot's operating handbook included a requirement to check the stall warning vane prior to engine start, which entailed:

> Stall Warning Vane .....PULL UP (Check Audible Voice Warning)

The investigation was unable to ascertain whether that check had been completed by the pilot prior to the flight.

The aircraft was not fitted with a flight data recorder or a cockpit voice recorder, nor was either required to be fitted by aviation regulation.

Airworthiness and maintenance

Records of compliance with all relevant service bulletins and airworthiness directives were found in the aircraft's logbooks. At the time of the accident, the aircraft had a current and valid maintenance release and there were no known unserviceabilities or deferred maintenance. No known deficiencies or prior conditions were identified that would prohibit normal flight.

On 20 April 2009, the US Federal Aviation Administration (FAA) released Airworthiness Directive (AD) 2009-08-05 requiring regular exhaust muffler inspections on XL2 aircraft. The AD, effective 20 April 2009, was issued to:

> …detect and correct cracks in the exhaust muffler, which could result in carbon monoxide entering the cabin through the heating system. Carbon monoxide entering into the airplane cabin could lead to incapacitation of the pilot.

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[6] Normal category aeroplanes were not intended for acrobatic operation, had up to nine passenger seats, and operated to a maximum take-off weight of less than 5,700 kg.

Meteorological information

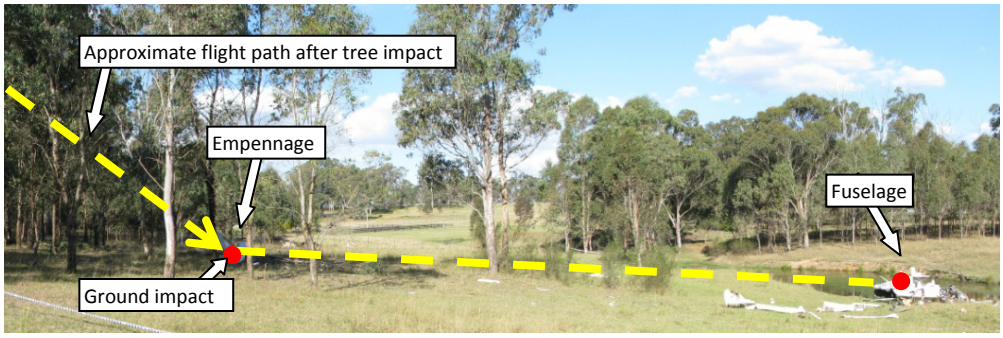
Bureau of Meteorology records for the Luddenham area showed temperatures of about 18 °C and north-easterly winds of 6 kts to 10 kts, gusting up to 16 kts at the time. Visibility was more than 10 km throughout the day, with occasional broken clouds[7] above 5,800 ft above mean sea level (AMSL).

Wreckage and impact information

On-site information

The evidence at the accident site was consistent with a descent at low forward speed, in a direction of about 190° magnetic. The aircraft initially struck four small trees, separating the outer section of the right wing. The aircraft then descended steeply and struck a larger tree immediately before impacting the ground in a right wing-low attitude. The empennage and wings separated from the fuselage and the aircraft came to rest next to a small dam, 52 m from the first tree strike (Figure 2).

Figure 2: Accident site



All major parts of the aircraft were accounted for at the accident site and the continuity of all flight controls was established. There was no evidence of a bird or wirestrike, or in-flight fire.

The left wing sustained crush damage consistent with tree impacts at an angle of bank of about 30° right wing low. There was no evidence of excess G-loading[8] on the aircraft.

The horizontal stabilator trim tab actuator was found in the full nose-up position. The aircraft's flaps were fully retracted.

The nose section and cockpit were substantially damaged and the engine had partially separated from the fuselage. The engine was recovered for technical examination.

The laminated wooden propeller shattered on impact with the trees and ground. Evidence of propeller rotation under power was found on a number of fallen tree

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[7] Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

[8] Stress imposed on a body due to an applied force causing an acceleration.

branches. A large section of one propeller blade was found in a tree 40 m to the right of the direction of aircraft travel, abeam the location of the initial impact with the ground.

The aircraft's fuel tank was ruptured during the impact sequence. Emergency services personnel reported that fuel had leaked from the tank for several minutes after their arrival at the site. The cockpit fuel control was found in the ON position.

The aircraft was fitted with an emergency locator transmitter, which was found 35 m to the right of the wreckage trail. The transmitter had activated but the aerial cable separated during the accident sequence.

Engine examination

The engine was transported to the engine manufacturer's facility in the US and examined under supervision of the National Transportation Safety Board.

The engine had been damaged by the impact and could not be operated. However, a detailed visual inspection of the engine revealed no abnormalities that would have prevented its normal operation and the production of the engine's rated horsepower.

Neither of the engine's two electronic control units could be tested due to damage sustained during the impact.

The engine was fitted with a full authority digital engine control (FADEC) system, which included a data recording capability. The FADEC data card was removed from the aircraft for possible data extraction. However, only the first 100 hours of the engine's operation was recorded on the data card. The engine manufacturer reported that the unavailability of recent data was due to a previously unidentified software defect. That software defect did not affect engine operation.

The engine examination included the examination of the aircraft's exhaust. That examination took place prior to the issue by the US FAA of AD 2009-08-05 (see the previous discussion titled *Airworthiness and maintenance*). The engine examination report noted:

> The exhaust system components exhibited impact damage. The end of the muffler was cut off to view the internal condition of the assembly; no abnormalities other than the impact damage were present.

Medical and pathological information

A post-mortem examination of the pilot was completed by the relevant state authorities. That examination indicated that the pilot succumbed to multiple impact-related injuries and did not identify any pre-existing medical conditions that may have contributed to the accident.

Toxicological testing detected:

- carbon monoxide at a level within the normal range
- traces of the cannabis metabolite, delta-9-THC acid
- no Delta-9-THC (a pharmacologically active cannabinoid).

The detection of delta-9-THC acid indicated the use of or exposure to cannabis within the previous few days or weeks. A post-mortem report by the NSW Police Service Clinical Forensic Medicine Unit stated that:

> ...there would not have been any impairment due to the presence of the inactive delta-9-THC acid

and that

> ...passive levels tend only to be detectable in blood if the exposure was due to intense cannabis smoke within a confined environment (eg. with a heavy smoker in a closed car or very small, closed room with several cannabis smokers).

Studies have shown evidence of performance impairment immediately after cannabis use, with a residual effect up to 24 hours later.[9] The investigation was unable to establish whether the pilot had a history of cannabis use.

Other information

Aircraft handling characteristics

In order to meet Federal Aviation Regulation (FAR) 23[10] airworthiness requirements, the XL2 had been assessed in-flight to be:

- recoverable from a one-turn spin
- not capable of entering an unrecoverable spin either at the entry into or during the spin
- controllable with full nose-up pitch trim at cruise speeds or lower, with a control force of less than 2 kg.

The aircraft manufacturer's flight manual gave a maximum weight, flaps-up stall speed of 57 kts calibrated airspeed in level flight. The aircraft's economical cruise speed was 105 kts.

The aircraft manufacturer reported that the aircraft would not enter a spin unless pro-spin flight control inputs were maintained.

On 19 August 2009, a Civil Aviation Safety Authority (CASA) test pilot conducted an assessment of an XL2 aircraft that was similar to CZX. The test pilot's assessment report concluded that:

> The Liberty XL2 was found to be a pleasant and capable light piston training aircraft. Aircraft performance, stability and control were well within the requirements of FAR-23 and there were no significant controllability anomalies. Stalling characteristics were relatively benign and, in conjunction with the effective stall warning system, should not hide traps for inexperienced pilots.

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[9] Newman, DG. (2004). *Cannabis and its effects on pilot performance and flight safety: A review*. Canberra, ACT: Australian Transport Safety Bureau (available at http://www.atsb.gov.au/media/36696/Cannabis_pilot_performance.pdf)

[10] US Federal Aviation Regulations, Part 23: Airworthiness standards: Normal, utility, acrobatic, and commuter category airplane.

The assessment noted that the pitch trim control switch and the flap control switch were electric switches on a console between the seats that would return to the central OFF position when released. Each switch needed to be held in one of two alternate positions (up or down) in order to adjust pitch trim or flap position using the same hand that controlled the power setting. The control layout meant that only one of those controls could be activated at a time.

The report determined that the test aircraft's stall warning would activate between 8 kts and 10 kts above the stall speed in level flight.

In September 2008, the FAA investigated a number of safety allegations that were received from a US flying school about the XL2 aircraft type and the aircraft manufacturer. The FAA investigation reviewed and evaluated the complainant's safety concerns, determined the aircraft's suitability for training and its compliance or otherwise with the related airworthiness performance requirements, and evaluated the continuing operational safety of the aircraft type. The FAA investigation concluded that:

- The aircraft met all applicable certification requirements and there were no specific safety concerns that had not been addressed.
- The aircraft was acceptable for training.
- The aircraft met the applicable handling characteristics airworthiness standards, including stability and flight control feel (sensitivity, friction, and forces).
- The aircraft's flight controls were relatively sensitive and had a response similar to an aerobatic aircraft. Pitch control in particular was somewhat more sensitive than other primary training aircraft types. However, the FAA considered this characteristic to be effective in teaching a pilot to fly the aircraft, which 'will produce a highly competent and qualified pilot.'
- The aircraft had 'very good' aerodynamic stall characteristics, with minimal buffeting and very good controllability. Recovery from the stall only required the release of control stick back pressure and the application of engine power.
- More flight instruction may be needed for the XL2 type compared with other aircraft that were used for primary training. This was entirely due to its sensitivity in pitch when entering a flare for landing, potentially leading to overcontrol and 'porpoising'.[11] However, the FAA noted that 'beyond landings, as a primary trainer the XL2 is as good as, and even superior to other trainers in teaching all other training manoeuvres.'
- The aircraft's accident/incident rates were 'comparable to those of similar airplanes.'

[11] Porpoising: oscillations in pitch, particularly as a result of control overcorrection.

ANALYSIS

Context

No evidence of any mechanical fault with the aircraft that could have contributed to the accident was found. The propeller damage, slash marks through the foliage, and engine examination indicated that the engine was probably producing substantial power prior to the accident.

The weather was benign and was unlikely to have contributed to the accident.

A post-mortem examination of the pilot did not identify any pre-existing medical conditions that may have contributed to the accident.

Development of the accident

The radar data recordings indicated that the aircraft departed straight and level flight and descended at an angle and rate of descent consistent with the aircraft having entered a spin. However, neither of the two witnesses saw the aircraft spinning, and the aircraft's relatively benign handling characteristics suggested that it was unlikely that the aircraft could have entered a spin inadvertently.

The aircraft damage and wreckage distribution indicated a steep, low-energy collision with terrain. This was not consistent with the very high rate of descent that would be expected during a spin or spiral dive, or with the aircraft's rate of descent as indicated by the radar information. There was no evidence of excessive aircraft G-loading that might occur during a spiral dive or a subsequent attempted recovery.

The witness observations, forward motion of the aircraft, and absence of spinning motion at impact all indicated that the aircraft was not in a spin at, or very shortly before impact. It was possible that the pilot could have entered and then recovered from a spin and been unable to prevent a subsequent collision with terrain. However, it was not possible to conclusively determine the reasons for the steep descent, or to establish the aircraft's movements in the period of time between the loss of radar information and the witnesses' visual observations.

While the investigation was unable to determine whether the aircraft's handling characteristics contributed to the accident, independent flight tests by the Civil Aviation Safety Authority and the United States Federal Aviation Administration found the XL2 aircraft type to be suitable for pilot training.

Cannabis exposure

The presence of an inactive cannabis metabolite detected by toxicological testing indicated the use of, or exposure to, cannabis in the previous few days or weeks, during which the pilot had been conducting flying training. There was no evidence that the pilot had been impaired by cannabis at the time of the accident; however, there is extensive evidence that the use of cannabis increases the risk of the impairment of pilot performance.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the collision with terrain of Liberty Aerospace Incorporated XL2 aircraft, registered VH-CZX, which occurred on 24 September 2008 near Luddenham, New South Wales and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factor

- The aircraft departed straight and level flight for reasons that could not be determined, and subsequently collided with terrain.

Other safety factor

- Traces of a cannabis metabolite were present in the pilot's blood, indicating previous use of, or exposure to cannabis.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

The investigation did not identify any organisational or systemic issues that might adversely affect the future safety of aviation operations. However, the ATSB has been advised of the following proactive safety action following the accident.

Flying school

Following the accident, the flying school modified its training syllabus to conduct additional instructional flights on the Liberty Aerospace Incorporated XL2 aircraft type prior to authorising extended solo flights.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included the:

- aircraft manufacturer
- air traffic control voice and radar recordings
- Bureau of Meteorology
- Civil Aviation Safety Authority (CASA)
- engine manufacturer
- flying school
- United States National Transportation Safety Board (NTSB)
- New South Wales (NSW) Coroner
- NSW Police Service
- student's flying instructor.

References

Newman, D.G. (2004). *Cannabis and its Effects on Pilot Performance and Flight Safety: A Review.* Retrieved from http://www.atsb.gov.au/publications/2004/cannabis_pilot_performance.aspx

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 and engine manufacturers, the flying school, the NTSB, the maintenance organisation that conducted maintenance on the aircraft and CASA.

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

Collision with terrain – Luddenham, NSW, 24 September 2008
VH-CZX, Liberty Aerospace XL2